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THE ELECTROLYSIS PROBLEM.

An old, familiar, and, at times, somewhat bothersome problem is the prevention of electrolytic corrosion of buried metallic structures. This problem has been with us since the introduction of the electric railway system in cities. Occasionally it has given rise to unfortunate disputes. A few years ago a stage was reached when the public took a great deal of interest in this question because of the exaggerated reports of the amount of destruction going on to city water-supply systems. It seemed to be believed that many such systems were in danger of immediate collapse, and that the entire blame should be laid on the electric railways. Fortunately, there has been less of this feeling of late.

It can not be disputed that electrolysis is caused by railway systems; but it has become the custom to attribute all corrosive effects to such causes. In many cases it is certainly true that the corrosion noticed was purely chemical—that is to say, produced by local conditions of the soil; or it may have been electrolytic, and yet not due to a neighboring railroad. When metals having different electrical properties are buried in moist earth, close together, they are very apt to constitute a sort of primary battery, and the more electronegative of the two metals will be corroded. This action has been used to prevent the corrosion of iron; in fact, it is an old practice to place blocks of zinc in steam boilers in order to prevent corrosion of the shell and tubes. What chemical action took place was then concentrated on the zinc. It has been suggested that this scheme might be applied with advantage to protect buried metals, but the application here would be a little more difficult and less likely to be entirely efficacious.

Two other solutions have been offered, and, indeed, put into effect. One is to provide a low-resistance return for the currents, so that there will be little or no tendency for them to leave the railway system. To provide a return circuit of such resistance that there would be no leakage to the ground is impractical, except when the return circuit is insulated from the ground; otherwise more or less current is sure to pass into the earth, and if there are metals in the neighborhood, laid so that they offer an inducement to the current, some of it will pass into them and make its way through them toward the station. Bonding the neighboring structures to the rails is supposed to provide a way of getting these currents back to the rails without damage to the pipe or cable in which they flow, but for bonding to be effective it must be applied wherever there is a tendency for the current to leave the pipe; and, moreover, the very act of bonding, which reduces the resistance between the pipe and the rail, and hence

of the path through the pipe, tends to draw more current into the pipe. It is questionable whether it is advisable to make these bonds of as low resistance as possible, unless it be intended to provide them at frequent points.

Another plan is to maintain the pipes and cables negative with respect to the ground. When this is done throughout the entire system there can, of course, be no electrolytic action, but means must be provided for drawing the current which flows into the pipes out of them. This can be done by connecting the pipes to the negative side of the generator; but it will be found necessary in such cases to carry negative feeders out to distant points of the piping system.

The problem may be approached from another direction. Instead of trying to get the current out of the pipe or cable, we may try to keep it from entering—that is, by constructing the pipe so that it will offer an unfavorable path to the flow of current, but little will tend to enter it. This plan has been tried in various places, not only in pipes, but with cables, and in certain of these it appears to have given good results; but here again it is not likely that this one plan will be suitable for all situations.

When the alternating-current railway system was introduced it was said that this would stop all electrolytic troubles. There can be no doubt that with an alternating-current supply there would be much less tendency for such corrosion to take place; but corrosion is possible, and has been shown again and again, and for that reason it is not safe to assume that the effect will be negligible in all cases, although it is probable that there are but few situations in which it would give rise to any trouble at all.

There is one feature which should be borne in mind throughout all such studies: no conclusions can be drawn by merely determining the quantity of current flowing in a pipe or cable. It must be known as well whether this current can leave the pipe by means of metallic conductors, or whether it must leak out into the earth; and, in the latter case, the probability of this current being concentrated in spots. Moreover, certain of the metals, such as cast iron, are not much affected by electrolytic action, and such structures are thick and heavy. On the other hand, the lead sheathing of buried cables is thin and easily corroded, so that a current which would be negligible in a small iron pipe might cause serious damage if allowed to flow along a telephone cable sheath.

There is no general solution for such problems. The proper way of meeting them is to admit the possibility and to make an exhaustive and careful study of each particular situation. It is not a difficult problem to make an electrical survey of the territory, and this survey should indicate whether special precautions are necessary and the proper way to apply them. The general idea should be to maintain the current in the rails, not to encourage it to pass into the pipes, but, when this can not be prevented, to supply a metallic return path which will prevent corrosion; but when installing this path the first requirement should not be overlooked. It would be better to install a number of rather high-resistance bonds at various points than to place one low-resistance connection which is expected to drain a long system of piping. As the situation stands to-day, the difficulties are fairly well understood, and when the engineers of the foreign conductors work in conjunction with those of the railway there should be no difficulty in rendering danger from this source entirely negligible.

LIGHT AND RADIATION.

It is most interesting to note how, occasionaliy, interest in practical matters which have been neglected, through some quickening action, is aroused, and then turns to the most recent developments in physical science for guidance and aid. The subject of illumination, the problems of lighting streets and buildings, are eminently practical ones, yet it is only recently that they have received more than a passing thought. Of course, much has been done to improve the methods of producing and distributing the agent by which the light is produced, but the matter stopped there, the engineer seeming to think that if he spaced his lamps a reasonable distance apart, the only thing he need consider was the cost of operating and maintaining them. No efforts were made to distribute the light so as to produce the best results, and after a certain amount of work had been done on the light producers, further progress was slow. Physicists had called attention again and again to the wastefulness of these lamps; enthusiastic inventors, it is true, had spent time and money, but no great advance had been made. It is a fact that the lamps as mechanisms have been greatly improved, but even the most perfect forms we have to-day are not so very much better than the lamps of the Ancients.

Within the last two or three years certain successful efforts to improve our lamps have brought about this awakening, and we are now entering into an active period in this development; but, as mentioned above, while, relatively—that is, compared with our lamps of ten years ago—we have gone forward, when compared absolutely—that is, with the advance which theory indicates as possible—we have made but little progress. This is a subject of great and wide interest. It appeals not only to the pure scientist, but to the manufacturer and to the operating companies. It has been discussed not infrequently of late, but new phases are continually arising, new light is being thrown by those who are leading in the advance, both along the scientific and the practical paths, and each new way of looking at the problems involved gives a clearer understanding of them and leads to a better appreciation, not only of what has been done, but what yet remains to be accomplished.

Such an occasion was the address delivered on the evening of March 22 before the Illuminating Engineering Society by Professor Otto Lummer, of the University of Breslau, one of the most distinguished investigators in the laws of radiant energy, as well as in the more practical field of photometry, more practical merely because it is a little closer in touch with human activity.

A report of this address is given on another page of this issue, but it is worth while emphasizing a few of the more sig-

nificant features of it. An investigation into the laws of radiation is essentially a study of energy and of the ether, and it therefore may lead to laws which are of the widest application. Physical science is deeply indebted to Dr. Lummer for his work in enunciating the laws of radiation. Others had preceded him, but to his efforts are largely due the mathematical expressions which we to-day believe represent them exactly. In other words, as he himself put it, these laws may now be considered laws of Nature, as much so as Newton's law of gravitation.

In his address Dr. Lummer made a distinction which should be clearly understood—that is, his classification of light producers according to whether they are luminescent or incandescent. The distinction at present is a broad one. Incandescence is the vibration of an atom as a whole, and produces light by a secondary vibration of its electrons. Luminescence is a vibration produced primarily in the electrons themselves. This distinction rests now on the idea of an atom as a body associated with electrons, and should this view be changed, the distinction, if it be still recognized, may be drawn in another way. It, however, leads to a fundamental law. To produce what is called cold light, the excitation must be exerted directly on the electrons, and not on the atoms. In other words, since the vibration of the atom as a whole is determined by its temperature, luminescence can not be produced as a temperature effect.

Unfortunately, we as yet know almost nothing about luminescence as defined, and can not point out any path along which immediate results may be looked for.

Another point was the suggestion that a great increase, relatively speaking, in incandescent sources may be obtained by raising the temperature, because the radiation from a body is proportional to the twelfth power of the temperature; and the practical suggestion was made that a more efficient source of light would be obtained by running incandescent lamps at a temperature about 100 degrees above that now employed, even though the life of the lamp was cut down to one-third. It was thought that the newer so-called high-efficiency lamps are dependent on such an increase in temperature for their better efficiency.

Another point brought out was that there is a limit to the efficiency to be obtained in incandescent radiators. The eye is most sensitive to the green rays, and if the temperature of the body be raised so that the maximum radiation comes from the green, that is the most efficient temperature. A further increase in temperature will only decrease the efficiency.

Dr. Lummer showed, in a most interesting way, how the laws of radiation are modifying our ideas of Nature; how they may explain astronomical problems—in fact, since they deal with the all-pervading ether, they must influence all natural phenomena.

SUBMARINE SIGNALING.

On another page of this issue an interesting description is given of the submarine signaling system which is now coming into wide use. The system is one which has been developed gradually from ideas suggested a number of years ago, but it is only comparatively recently that satisfactory apparatus for making such signals and receiving them has been devised.

The system consists in sounding a bell under water, advantage being taken of the better conductivity of water for sound. This sounding may be done by any convenient means, frequently by compressed air, sometimes electrically when compressed air is not suitable, at other times by hand. The receiver, on the other hand, is essentially an electrical device. It is, in fact, nothing more than a special form of microphone attached to the skin of the vessel which is to detect the signals. By means of two of these microphones and suitable telephone receivers the direction from which the sound comes may be determined, in much about the same way as a man determines the direction in which a sound comes through the air, though the determination in the former case is much more accurate, primarily because the sound comes directly through the water, and is not blown from one side to the other by currents of air, and also because the arrangement of the apparatus on the ship gives a more delicate means. Moreover, the signal depends only upon the sounder, the receiver and the medium, which in this case is water; and the medium remains practically unchanged, neglecting, of course, the slight changes due to temperature. The system therefore is independent of wind and weather, is equally useful by day and by night, in good weather and in bad, and in addition to these has the valuable characteristic of carrying much further than a sound in the air. These advantages are of the greatest importance and promise a wider extension of this method of signaling. For the present it will cooperate with the other systems in use, but it seems likely to become, before long, the most important of all. Fortunately, the equipment required by any vessel wishing to utilize these signals is simple and inexpensive.

A MATERIAL PROPERTY OF THE ETHER.

To most of us the ether is a hypothetical medium assumed as a convenient way for explaining certain physical phenomena. Other than this it has for us no significance. True, many, from their study of these phenomena, have endeavored to describe the ether by giving to it certain properties which seemed necessary, according to the theory held by the individual; but to others these have seemed merely interesting scientific speculations.

A different idea is that given in a recent article by Daniel F. Comstock, appearing in *Science*. This calls attention to the ordinary view of the ether—that it is a hypothetical medium—and then points out that since the velocity of light is independent of the source, and depends only upon the ether, that there is such a thing as absolute motion. Motion must be absolute, because, by measuring the velocity of light, it can be determined whether the observer is moving with respect to the medium which transmits the light or not. If, then, motion is absolute, the ether possesses a positional property. The possession of such a property is one of the characteristics of matter; therefore the ether, to this extent, at least, may be considered material. The study of electric science is fundamentally a science of the ether, and any view which tends to lend definiteness to our conception of this medium is helpful.

American Institute of Electrical Engineers.

On the evening of March 22 a special meeting of the American Institute of Electrical Engineers was held under the auspices of the High-Tension Transmission Committee, Ralph D. Mershon, chairman. Two introductions to the discussion were presented, the first by Paul M. Lincoln, entitled "Motor-Generators *versus* Synchronous Converters, with Special Reference to Operation on Long-Distance Transmission Lines." The other was by B. A. Behrend, and was entitled "The Practicability of Large Generators Wound for 22,000 Volts." Mr. Lincoln's introduction was in part as follows:

The particular problem considered is the following: wanted, direct-current power of approximately constant voltage; for instance, for railways, 500 to 700 volts; for an incandescent lighting system, 100 to 275 volts; for an electrolytic process, any direct-current voltage. Given as a source of power, a long-distance alternating-current transmission system, which may be either twenty-five or sixty cycles, may have a varying voltage at point of delivery, may have the variation occur either on account of the load taken by our particular station or independent thereof and may have a somewhat variable frequency. Problem, what shall be used for making the desired transformation; synchronous converters? motor-generator sets with synchronous motors? or motor-generator sets with induction motors?

The comparison is made in regard to the following points: reliability, voltage regulation, corrective effect, efficiency, cost, parallel operation, starting.

As a relative comparison of the reliability of the methods under consideration in railway work, the following is advanced as the author's opinion. The number given indicates the relative number of hours that the apparatus would be out of service within a given time on account of defects inherent in the apparatus:

	Hours.
Twenty-five-cycle synchronous converter	10
Induction motor-generator	14
Synchronous motor-generator	17

The term "voltage regulation" here is confined to the changes that may take place in the direct-current voltage. It embraces at least three distinct features: automatic change in voltage with change in load; ability to adjust the initial voltage; variations in direct-current voltage with variations in incoming line voltage and frequency.

In respect to the first, all methods under discussion are equal.

In respect to the second, the synchronous converter suffers its greatest handicap.

As the third feature, the converter probably suffers by comparison with the motor-generator.

By "corrective effect" is meant in general the results that may be obtained in respect to the voltage regulation of a transmission line by means of a change in the power-factor of the current taken. From the standpoint of corrective effect, the synchronous motor-generator has decidedly the advantage over the straight converter, while the induction motor-generator is entirely neutral.

At the end of a transmission line power is usually sold by the kilowatt hour, or some other function that is proportional to it. The amount of the monthly bill will be proportional to the meter-reading, and the efficiency of the transformation therefore enters as a direct function in the cost of power. As a reasonable estimate of the all-day efficiency under about seventy-five per cent load, the following is submitted for units of 500 kilowatts capacity or thereabouts:

	Per Cent.
Twenty-five-cycle synchronous converter	93
Synchronous motor-generator	85
Induction motor-generator	84

The following calculation based on the above is somewhat surprising. Assume a station using a 500-kilowatt unit an average of eighteen hours per day at seventy-five per cent average load. Assuming power to cost one cent per kilowatt-hour, the saving in power bill per year of converter over motor-generator is $2,100. Capitalized at six per cent, this represents $35,000. In other words, one could afford to pay $70 per kilowatt more for converters than for motor-generators.

In regard to cost, the synchronous converter has an immense advantage. Here again, as in efficiency, it is the cost of one machine against two; and the cost of the converter is not far different from that of each machine that goes to make up the motor-generator. An approximate idea of relative cost is given in the following:

	Per Cent.
Synchronous converter	60
Synchronous motor-generator	100
Induction motor-generator	100

The two points to consider in parallel operation are: proper division of direct-current load between units; proper operation so far as alternating-current ends are concerned, such as freedom from "hunting," etc.

As to division of direct-current load, there is no question either on direct-current generator or converters.

As to operation on the alternating-current ends, the induction motor-generator is the least liable to trouble, since "hunting" or "pumping" can not take place on that type of machine. The synchronous motor and converter are on a par in regard to hunting. However, with the modern construction of synchronous machines, including as they do heavy dampers, there is so little probability of hunting that it may be entirely neglected. The only places in which hunting is apt to occur are in cases where antiquated generators are used and where the ohmic line drop is very high. Neither of these is apt to occur in practice.

There is not much choice in the starting qualities of the three methods, but what there is would cause them to be arranged in the following order:

1. Induction motor-generator.
2. Synchronous converter.
3. Synchronous motor-generator.

On three of the preceding seven counts the converter has a distinct advantage.

On one more all methods are taken as being on a par.

On the remaining three, one of the other methods has the advantage. In one of these the disadvantage of the converter is not marked. The converter's disadvantage on the other two largely disappears with the addition of a means of voltage regulation.

This analysis, therefore, would seem to indicate that there are but few cases where the motor-generator should be used in preference to the synchronous converter.

Following Mr. Lincoln, Mr. Behrend presented his introduction to the discussion on the practicability of large generators wound for 22,000 volts.

With the increased capacity of individual units of alternating-current generators it is natural that the potential for which these generators are wound should be continually increased. It commends itself to limit the current capacity of generators, as the distribution and conduction of large currents from the generators to the switchboards is cumbersome and expensive. Historically, the increase in voltage with the increased capacity of individual units and of power plants may be briefly summarized. The Niagara generators of approximately 3,500 kilowatts capacity, put into operation about ten years ago, were designed for 2,200 volts. The 3,500-kilowatt generators of the Metropolitan Street Railway Company, of New York, were designed for 6,600 volts. The 5,000-kilowatt generators installed in the stations of the Interborough Rapid Transit Company, in New York, were designed for 11,000 volts. The large gener-

ators for the Brooklyn Rapid Transit Company, of 7,500 kilowatts, were designed for 11,000 volts also.

The question of the importance of higher voltage in future plants can not be discussed without reference to prime movers. The four types of prime mover which are likely to be of great importance in the immediate future are:

1. The hydraulic turbine.
2. The gas engine.
3. The reciprocating steam engine.
4. The steam turbine.

1. The field of the hydraulic turbine for large capacities, by which I mean capacities of 7,500 kilowatts or above in individual units, is not likely to be of great importance at the present.

2. The gas engine has been successfully built for capacities up to 2,000 kilowatts, and while it has unquestionably a great future for greater capacities, nothing as yet has been done to allow the application of the gas engine in connection with electric generators of 7,500 kilowatts or above.

3. The reciprocating steam engine still holds its own for small capacities, but for the capacities which we are here considering it has been superseded by the steam turbine.

4. The steam turbine in its present condition is preeminently adapted to large individual capacities. I should consider a steam turbine of 7,500 kilowatts a comparatively small unit, and I am firmly of the conviction that steam turbines of 10,000 kilowatts or 15,000 kilowatts, and even of 25,000 kilowatts, will, before long, be developed and put into successful operation.

STEAM-TURBINE GENERATORS FOR LARGE CAPACITY, 7,500 KILOWATTS TO 15,000 KILOWATTS AND ABOVE.

The difficulties encountered in winding generators for potentials of 20,000 volts or 25,000 volts are primarily mechanical difficulties. A coil containing a large number of small wires does not make a very mechanical piece of work. It would, therefore, appear to me desirable, for the reasons here mentioned and some others, that the individual coils should consist of as few conductors as possible and that these conductors should be of such size as to enable the making of mechanically and electrically strong coils. Let us take a concrete example. A certain 7,500-kilowatt turbo-generator wound for 11,000 volts and operating at 750 revolutions per minute at twenty-five cycles has six conductors per slot. A 7,500-kilowatt generator wound for 22,000 volts, if designed along similar lines, would have twelve conductors per slot. Increasing the capacity of the generator from 7,500 kilowatts to 15,000 kilowatts would enable the generator to be designed with six conductors per slot, and the difficulty produced by the higher voltage would be that of insulating the coils for the higher potential against ground and against one another.

The insulation of the coils against ground is easier to obtain than against one another. The question of insulating the coils from one another is particularly difficult in turbo-generators on account of the crammed conditions of the winding space, but at the present state of the art it is possible to obtain the necessary insulation for 22,000 volts, although this can be done only with considerable expense. As soon as there will be a demand for large units wound for 22,000 volts, this demand will be met by machines carefully designed for these conditions.

The question of reliability of service is closely allied to that of quick repairs. It will be urged that not only is the danger of the breakdown of a 22,000-volt generator greater than that of a 11,000-volt generator, but also the repairs, consequent upon a breakdown, will be more difficult to make on the 22,000-volt generator. While this statement is perfectly true, a plan can readily be devised so as completely to defeat this argument. In a large power-house in which a number of units of large capacity of the steam-turbine type are installed, the only rational way to make quick and satisfactory repairs consists in the carrying of spare parts. It will commend itself to the operators of power stations to carry a spare revolving field for one of these units and a complete set of spare armature coils. It must be insisted upon that the armature coils of these high-potential generators can readily be replaced, and, unless the machines are designed to permit this, it would be necessary even to carry a spare stator completely wound, which would be almost equivalent to having a spare unit in the power-house.

ECONOMY OBTAINED BY THE USE OF GENERATORS WOUND DIRECTLY FOR 20,000 VOLTS.

The chief gains obtained by winding generators of large capacity directly for the high potential required for distribution consists in the simplification of the power plant and, probably, in a slightly reduced first cost. The question of reduced cost should certainly be considered a very minor factor, as reliability of service should be the criterion either in favor of, or against, the adoption of generators wound directly for high potential.

GENERATORS, REGARDLESS OF SIZE, FOR 20,000 VOLTS.

For the sake of ascertaining the feasibility of insulating coils for 25,000 volts, the writer has had in operation a 150-kilowatt generator wound for 25,000 volts, sixty cycles, 600 revolutions per minute. This generator has been in operation for months, operating day and night under full load. There is no doubt that there may be a limited field for units of small capacity wound for potentials above 11,000 volts, and the object of this paper is to call to the attention of the engineering profession the feasibility of generators of as small capacity as 150 kilowatts, being wound for as high a potential as 25,000 volts. The regulation, the heating and the efficiency of this machine are satisfactory. Should such machines be used in the future it must always be insisted upon that the exchange of coils can readily be effected. In the 150-kilowatt generator referred to in this paper it has so far not been necessary to replace any of the coils on account of defective insulation.

SUMMARY.

Where individual units of very large capacity are installed in power plants, a potential of 20,000 volts is feasible, and it is to be recommended in units of 10,000 kilowatts capacity and above.

Where individual units of small capacity are needed for a potential of 20,000 volts, the conditions can be met in most cases, even down to capacities of 150 kilowatts.

Supplementing his paper, Mr. Behrend said that he thought there will be little call for units larger than 7,500 kilowatts in capacity. He also called attention to the fact that repairs on the high-voltage generators were more difficult to make. He thought, however, that if a generator could be wound for 20,000 volts, avoiding the use of oil-filled transformers for transmission, simplification would result.

The discussion was opened by C. E. Skinner, who thought that generators of 20,000 volts and above would hardly be considered at all for transmitting directly without the use of transformers, except there be a considerable gain in cost. The decreased cost of such an installation would result from the omission of transformers, the omission of some apparatus on the switchboard, and the requirement of smaller space for installation. He thought, however, that with the use of the lower-voltage units, considerable equipment expense could be eliminated, as with the lower-voltage apparatus expense for

spares could be reduced materially. The constructional difficulties of high-voltage machines were much greater than with low-voltage machines and transformers. The high-voltage machines are of necessity more subject to breakdowns and are also harder to protect from lightning.

A. H. Armstrong did not consider the use of a high-voltage generating apparatus feasible, and strongly endorsed the use of lower voltage with transformers. With regard to the use of motor-driven generators, as against rotary converters, it was a question of expediency and cost. For railway work, where close voltage regulation is not a requirement, the rotary converter is going to stay with us as long as direct-current motors are used. Where the bulk of current is used for lighting purposes it will be necessary to go to the motor-generator set. Where there is a mixed system of railway and lighting distribution it is very probable that the motor-generator sets will be used for lighting, and the rotary converter continue in use for railway work.

W. L. Waters said that the question of reliability is almost entirely a question of the care that the machinery gets. In one station there will be all kinds of trouble, and in another there will be no trouble at all. As regards voltage regulation, the motor-generator, he thought, is much superior to the rotary converter, because in the rotary converter, whenever you start to vary one thing you vary another. If you vary the power-factor, you vary the voltage; but if you introduce into the system automatic compounding, you compound the line, and not the machine. This means that the voltage on the line is changed, so that if you want to have a machine that is flexible, the motor-generator is really the only one to be considered.

H. G. Stott stated that in the early work at Niagara Falls rotary converters were used for lighting work, but the variation of potential was so great that they had to be abandoned and motor-generator sets used. A few years later, after the governors on the water turbines had been greatly improved, and speed regulation became more nearly perfect, the motor-generator sets did not give as good results as the rotary converters.

With regard to Mr. Behrend's paper, the question of large generators was one of insulation, not of the generator alone, but of the whole system. It was a question of oil-insulated *versus* air-cooled transformers. He thought that the protection afforded generators by transformers in a low-voltage system was great. He could not recollect having heard of a generator being destroyed by lightning where transformers were interposed between the generator and the line. On the other hand, it was common to hear of generators being destroyed when connected directly to the line. Several years ago he had investigated the relative cost of transmitting power between two power plants of about 2,500 kilowatts, by means of raising the potential to 25,000 volts, and transmitting it at a lower potential of 11,000 volts. He found the total cost was almost the same in both cases.

Ralph D. Mershon did not agree with Mr. Lincoln as to the relative reliabilities of the motor-generator set and synchronous converter. He had been closely connected with one installation where power is supplied in part by motor-generator sets of sixty cycles, and by rotary converters of thirty cycles. There had been very little trouble with either. Contrary to Mr. Stott's experience, he knew of several cases where generators with transformers interposed in series with the line had been damaged by lightning discharges.

Mr. Stone thought that the rotary converter had an advantage in the ease with which it could be started either from the alternating-current end with low-voltage taps, or from the direct-current side. He had seen rotary converters with capacities of 1,500 kilowatts brought up from rest on the alternating-current side and thrown on the line inside of forty seconds. Of course, this means a large rush of current, but it can be done in cases of emergency. He would reverse the order given by Mr. Lincoln as to relative reliabilities, and put the synchronous motor ahead of the induction motor. From a careful study of various installations he had heard of more complaints on induction motor sets than on synchronous sets.

Percy H. Thomas emphasized the importance of insulation for the high-voltage generators. The liability of the high-potential apparatus to break down was great enough to warrant a very careful investigation. The end coils were particularly vulnerable, and in case of lightning discharges, where the first coil was short-circuited it was often the case that the short persisted, jumping across to the second, then the third, and so on, sometimes necessitating the entire rewinding of the machine. With regard to the high-tension generator, the matter of parallel operation also introduced an unwelcome feature. With the high-potential unit connected directly to the line, all of the switching and paralleling operations would have to be carried on at the higher voltage. With the lower voltages this could be done more conveniently and safely.

Philip Torchio stated that he had had occasion to deal with a large water-power proposition in which the conditions seemed to warrant the use of 22,000-volt generators, the total length of the transmission line being about fifteen miles. Manufacturers were asked to make a preliminary study of machines for 2,250-kilowatts, 25,000 volts, three-phase, sixty-cycle, 112.5 revolutions. Under these specific conditions it was found that the costs and efficiencies of the different voltage generators would be approximately as follows: Voltage of generator, 2,300; relative cost, 100 per cent; relative efficiency, ninety-six per cent. Voltage of alternator, 15,000; relative cost, 130 per cent; relative efficiency, ninety-five and one-quarter per cent. Voltage of alternator, 25,000; relative cost, 155 per cent; relative efficiency, ninety-four and one-fifth per cent. From this it would appear that, as far as cost and efficiency are concerned, there would hardly be any difference between the low-voltage generator with step-up transformer and the 25,000-volt generator. On the other hand, if step-up transformers are used, great savings can be made in the copper and transmission line by raising the voltage higher, say, to 44,000 volts.

Charles F. Scott emphasized the importance of engineers, in a discussion of this nature, bringing out both the advantages and disadvantages of all types of apparatus. It was not possible for one type of machine to be a panacea for all troubles, and the best interests of all could be conserved when all types were freely discussed. The simplest kind of apparatus is the direct-current generator, on the one hand, and the induction motor on the other; but if these are not found in practice to give the best results, it will be interesting to know just why.

Mr. Lincoln, in replying to the questions brought up in the discussion, wished to lay emphasis on the point brought out by Mr. Stott, namely, that the oil which is used in the oil-cooled transformers is of advantage in that, in many cases, it is self-healing and advanced the desirability of the transformer combination over the high-voltage generator. Another reason why, for some distribution systems, the high-voltage generator would not apply was that the cable manufacturers are not prepared to furnish cables insulated for the high voltage.

In concluding the discussion Mr. Behrend stated that the use of the word "practicability" in the title of the introduction which he had prepared was hardly correct; this should have been "feasibility." He wanted it understood that he did not take the stand of advocating the high-voltage proposition. He had been asked to contribute the introduction for the sake of raising a discussion, and this was the topic which had fallen to his lot.

The meeting was then adjourned.

CONTINUOUS-CURRENT ARMATURE WINDING DIAGRAMS.

BY H. M. HOBART.

For all except comparatively small designs, a type of armature winding known as a "multiple-circuit winding" is almost exclusively employed for continuous-current machines. This winding owes its name to the circumstance that there are as many conducting paths (circuits) for the current to traverse in passing through the armature from the negative to the positive brushes, as there are poles in the machine. Multiple-circuit windings may either be "simplex" or they may be "multiplex" (*i. e.*, duplex, triplex, etc.). Multiple-circuit multiplex windings are, however, so little employed that it is not convenient to always state explicitly that a certain armature has a multiple-circuit *simplex* winding. It is, on the contrary, customary and practicable, to simply state that it has a multiple-circuit winding and to realize that if it had a duplex or triplex winding, it would be explicitly stated that it had a multiple-circuit *duplex* winding or a multiple-circuit *triplex* winding, as the case might be. So let us, for a considerable part of this article, completely dismiss from our minds the knowledge of the existence of any type of windings other than multiple-circuit *simplex* windings and let us refer to these as "multiple-circuit" windings.

Let us, furthermore, begin by limiting our thoughts to windings with but one turn between adjacent commutator segments. Such an elementary turn with its corresponding commutator segments, is illustrated diagrammatically in Fig. 1. Suppose that this is a turn of a four-pole winding with 96 segments. Then there will be 96 turns and hence $2 \times 96 = 192$ face conductors. If, as in Fig. 2, we denote the left-hand conductor by 1 then the number of the corresponding right-hand conductor of this single turn will be found by adding

$$\frac{192}{4} \pm 1 = 47 \text{ or } 49 \text{ to } 1.$$

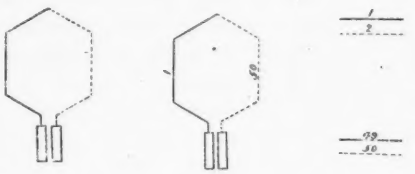
Hence, as right-hand conductor of this turn, we should choose

$$1 + 47 = 48, \text{ or } 1 + 49 = 50.$$

Let us choose the latter, and designate the right-hand conductor as number 50, as shown in Fig. 2.

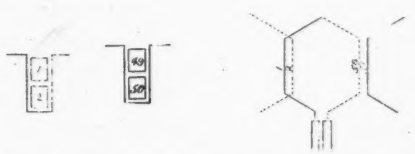
Let us make a practice of writing the number of each conductor in some such relative position as that shown in Fig. 2.

In Fig. 3 we have thus drawn and numbered conductors 1, 2, 49 and 50. Let us furthermore introduce into Figs. 2 and 3 the additional convention of representing all even-numbered conductors by dotted lines. If this is a winding with two conductors per slot, and if 1 and 2 are the top and bottom conductors in one slot, then a moment's reflection will show that 49 and 50 are top and bottom conductors, respectively, of another slot, as indicated in Fig. 4.



FIGS. 1, 2 AND 3.—CONVENTIONAL ELEMENTS OF WINDING DIAGRAM.

We thus have the further rule which we must always keep distinctly in mind, that top conductors are denoted by odd, and bottom conductors by even numbers. Also the top conductors are represented by full lines and the bottom conductors by dotted lines.



FIGS. 4 AND 5.—CONVENTIONAL ELEMENTS OF WINDING DIAGRAM.

It might be supposed that as 1 and 50 constitute the two sides of one turn, 2 and 51 would constitute the two sides of another turn. This is not the case. Conductor No. 2 is connected to another conductor to the left and not as yet shown in the diagrams, while conductor

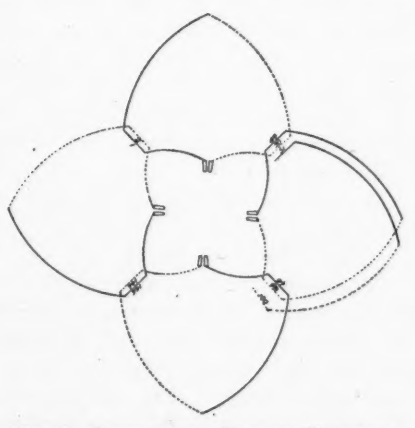


FIG. 6.—ELEMENT OF WINDING DIAGRAM.

No. 51 is connected to a conductor to the right and not as yet shown in the diagrams. In fact, the state of affairs so far disclosed by our investigation, is that illustrated in Fig. 5.

We thus see that all top conductors (*i. e.*, all odd-numbered conductors) are connected over to the right, and all bottom conductors (*i. e.*, all even-numbered conductors) are connected over to the left. Just as conductor No. 1 is connected to conductor No. (1 + 49), *i. e.*, to conductor No. 50, so conductor No. 51 is connected to conductor No. (51 + 49), *i. e.*, to conductor No. 100. (See Fig. 6.) Similarly, conductor No. 49 is connected to conductor No. (49 + 49), *i. e.*, to conductor No. 98, and conductor No. 97 to conductor No. (97 + 49), *i. e.*, to conductor No. 146, and conductor No. 145 to conductor No. (145 + 49), *i. e.*, to conductor No. 194.

But, it will be asked: "Where is conductor No. 194? There are only 192 conductors." This, of course, is true, but as there is neither end nor beginning to a circle, so also, in the case of a multiple-circuit armature winding, which is arranged on the periphery of a circle, we may take conductor No. 194 as having its equivalent in conductor No. (194 — 192), *i. e.*, in conductor No. 2. Thus, finally, we have found out that which we wanted to know a few paragraphs back; namely, the number of the conductor to which conductor No. 2 is connected. The quantity 49 which we add in each case, in the process of connecting up, is called the "winding pitch," or, briefly, the "pitch" and is denoted by y. We call the two ends of the armature the "front" (or commutator) end, and the "back" end. The quantity 49 is the "back-end pitch," that is to say, it is the number to be added to any conductor in order to find out the conductor to which, at the back end, it is connected. For the present it should merely be noted that at the "front" end, both ends of any turn are carried to commutator segments.

It is very convenient to diagrammatically represent windings as shown in Fig. 6. For the time being, however, the only conductors shown and numbered are the ten conductors—1, 2, 49, 50, 97, 98, 145, 146, as also 51 and 100, as these are the only ones to which allusion has as yet been made.

In such a diagram it has become conventional practice to let the inside of the diagram represent the commutator end, and the outside the back end. The face conductors are diagrammatically represented by radial lines and the end connections by other lines, the inclination or curvature of which is so chosen as to give a maximum of distinctness to the diagram.

The final practice of diagrammatically representing commutator segments in

winding diagrams will be shown in a subsequent figure. In the case of Fig. 6, the eight little rectangles toward the centre of the figure will be readily recognized as intended to represent the commutator segments.

The only irregular feature of the dia-

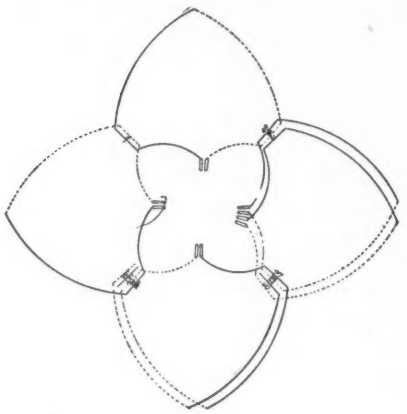


FIG. 7.—ARMATURE WINDING DIAGRAM.

gram of Fig. 6 relates to conductors No. 51 and 100. Just as conductor No. 100 constitutes the right-hand side of the turn of which conductor No. 51 is the left-hand member, so also is conductor No. 53 connected over the back end to conductor No. (53 + 49), *i. e.*, to conductor No. 102.

Thus also we have: conductor No. 1 connected at the back end to conductor No. 50; conductor No. 3 connected at the back end to conductor No. 52; conductor No. 5 connected at the back end to conductor No. 54.

These steps are taken in Figs. 7 and 8, and were we to carry this out all the way round the circumference we should obtain a diagram of which a portion is shown in Fig. 8.

In Fig. 9 we have added the two front

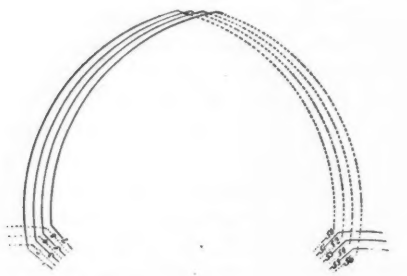


FIG. 8.—BACK-END CONNECTION.

ends of each turn, carrying them to independent commutator segments. But this gives us 192 segments, and we have stated that our winding, which comprises 192 conductors, has *one turn, i. e., two conductors* per commutator segment, and hence only 96 segments. Thus we must merge every *pair of adjacent* segments into a *single* segment, taking care, however, to take such pairs as are not the neighboring terminals of a single turn, for that would simply give us a set of 96 short-circuited turns.

With this precaution we shall obtain the diagram of Fig. 10, in which the radial dotted lines on the commutator are the lines which in Fig. 9 divided the now merged segments.

In Fig. 10a these dotted lines are suppressed. This is still not quite in the conventional form. There is still required the further minor modification introduced in the complete diagram of Fig. 11, and consisting in connecting the commutator segments to the winding by means of short radial lines, which have their equivalent in practice in the leads from the winding to the commutator, although, of course, *some* armatures are actually constructed in accordance with the method indicated in Fig. 10; that is to say, the ends of the turns are carried directly to the segments. More often, however, the method actually adopted corresponds with the diagram of Fig. 11, in which it is indicated that additional strips are intro-

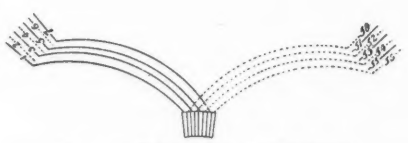


FIG. 9.—FRONT-END CONNECTION.

duced, connecting from the winding to the commutator.

In Fig. 11 we have now drawn the complete winding diagram for the armature, which would be arrived at by simply continuing Fig. 10. To clearly indicate the front and back winding pitches, the turn comprising conductors 1 and 50 has been thickened in.

We see that the "front-end pitch" is equal to

$$50 - 3 = 47,$$

i. e., at the front end, conductor No. 50 is connected to conductor No. 3. As the connection at the front end is carried out in the opposite direction, *i. e.*, counterclockwise, we may say that the front-end pitch is in this case negative, *i. e.*, it is equal to — 47.

It is customary to denote the winding pitch by y, and to distinguish between the "back-end" and the "front-end" pitches by designating them as

y_b = "back-end pitch"

and

y_f = "front-end pitch."

In the winding of Fig. 11 we have

$$y_b = 49,$$
$$y_f = 47.$$

We may denote the mean pitch as y, *i. e.*,

$$y = \frac{y_b + y_f}{2} = \frac{49 + 47}{2} = 48.$$

Thus y (*i. e.*, the *mean* pitch), is equal to the total number of face conductors

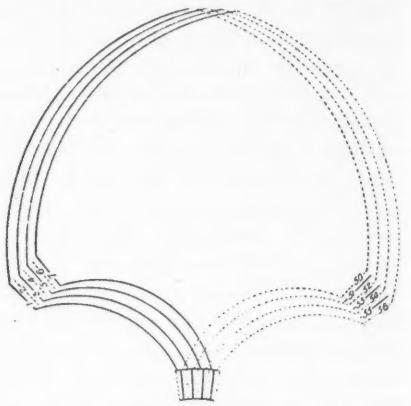


FIG. 10.—ELEMENTS OF ARMATURE WINDING DIAGRAM.

divided by the number of poles. In this case

$$y = \frac{192}{4} = 48.$$

The precise values of the front and back pitches are determined by taking the one greater by 1 than the value of the mean pitch, and the other less by

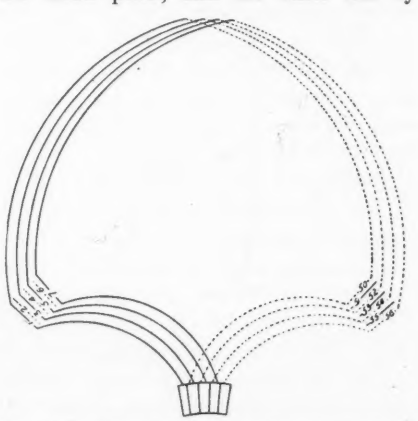


FIG. 10A.—ELEMENTS OF ARMATURE WINDING DIAGRAM.

1 than that value; thus in the present case we have

$$y_b = y + 1 = 48 + 1 = 49,$$
$$y_f = y - 1 = 48 - 1 = 47.$$

Let us employ this same number of face conductors, *i. e.*, 192, but connect them up into a six-pole winding.

$$y = \frac{192}{6} = 32.$$

$y_b = 32 + 1 = 33$ and $y_f = 32 - 1 = 31$.

This winding diagram is given in Fig. 12.

In carrying out the design of the wind-

ing in the drafting office and in the construction work in the shop, a considerable degree of familiarity with the electromagnetic properties of windings is highly desirable. It is not, however, either necessary or desirable to deal with the subject on quite the same lines as would be suitable in an article intended to be employed exclusively by those entrusted with the task of the pre-calculation of the electromagnetic design. Such individuals can profitably familiarize themselves with the aspects of the subject on which emphasis is laid in this article; they should, however, also master the further aspects of the subject as set forth in treatises dealing more especially with electromagnetic design.[1]

It is believed that in view of the above explanation, the less frequent allusion to the question of current distribution in the windings, will be appreciated. Briefly, it may be stated that where desirable to indicate the paths of the current, the direction *through the winding* from negative to positive brushes is indicated by arrowheads affixed to the radial lines representing face conductors. As the current changes its direction as the conductors pass under each successive pole, it is only practicable in a single diagram to indicate the direction at some particular instant. The rule for ascertaining the direction of the current for the case of a machine when employed as a dynamo,[1] is as follows:

When a conductor passes under a north

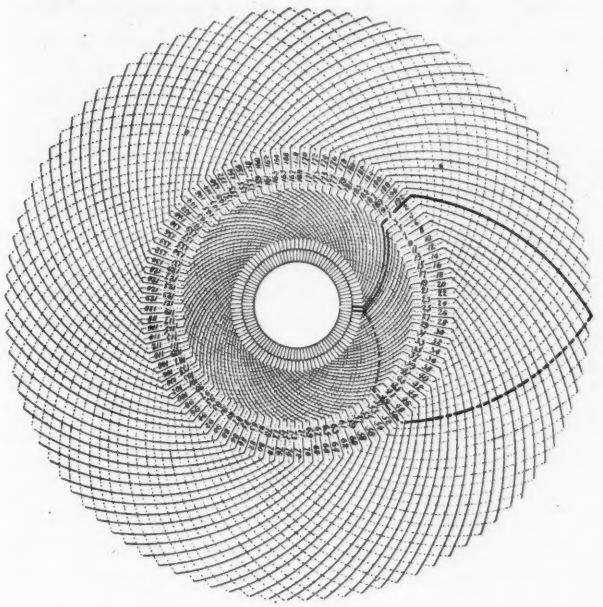


FIG. 11.—COMPLETE WINDING DIAGRAM FOR ARMATURE.

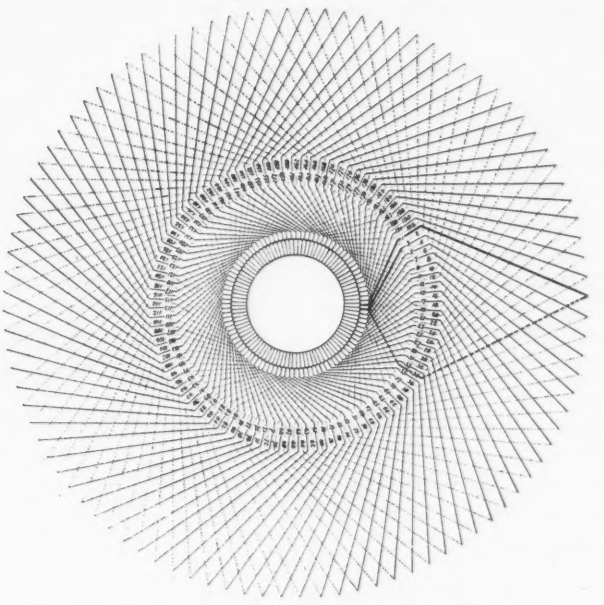


FIG. 12.—COMPLETE WINDING DIAGRAM FOR ARMATURE.

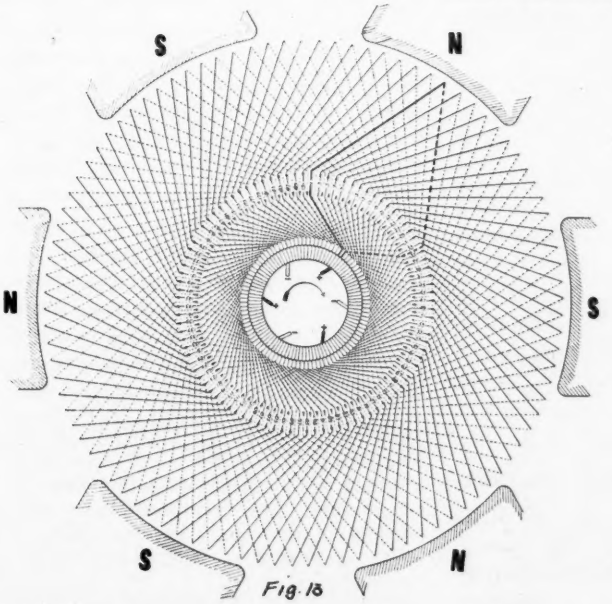


FIG. 13.—COMPLETE WINDING DIAGRAM FOR ARMATURE.

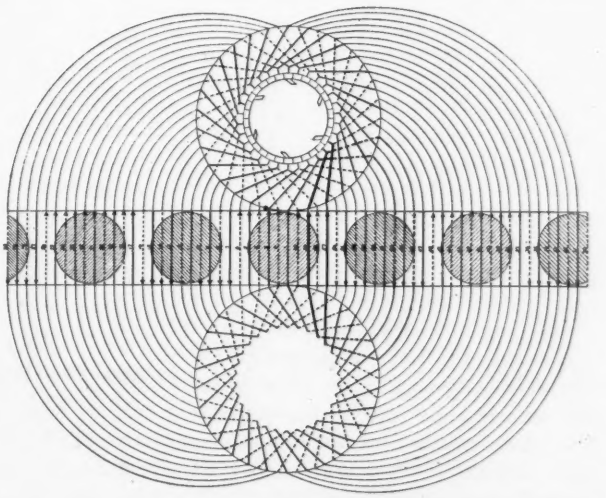


FIG. 14.—DEVELOPED WINDING DIAGRAM FOR SIX-CIRCUIT, SIX-POLE WINDING. SIXTY CONDUCTORS. $Y_f=9$. $Y_b=11$.

[1] Among these treatises the writer naturally prefers those in which the nomenclature here employed has been adopted. The most extensive treatise is "Armature Windings." Parshall and Hobart, New York. D. Van Nostrand Company, 1895.
The subject is much more briefly dealt with in "Electric Machine Design," Parshall and Hobart, London, offices of *Engineering*, 1906; "Electric Motors," H. M. Hobart, London, Whittaker & Company, 1904, and "Elementary Principles of Continuous-Current Dynamo Design," London, Whittaker & Company, 1906.

Dr. Thompson and Professor Arnold have handled the subject most ably; the nomenclature they employ is, however, considerably at variance with that in the other treatises and in the present volume. Cramp, however, in a most interesting little volume ("Armature Windings of the Closed-Circuit Type," London, Biggs & Company, 1906) has employed substantially the nomenclature adopted in the present treatise.

[1] It is almost superfluous to state that when the machine is run as a motor the current will flow in just the opposite direction for a given direction of motion of the conductor under a pole of given polarity. The electromotive force induced in a conductor by its passage through the magnetic field is the same in both cases, but in the case of a dynamo the current flows under the influence, and in the direction of, this induced electromotive force, whereas in the case of a motor it flows in the direction of, and under the influence of, an external electromotive force which is greater than the induced (and in this case counter) electromotive force in *opposition* to which it flows

pole in a clockwise direction from the observer's standpoint, the electromotive force thereby induced in the conductor and the current flowing when the circuit is closed, will be directed *away from* the observer.

In this article the arrowheads always indicate the direction of the *induced* electromotive force, *i. e.*, the direction of both electromotive force and current for the case of a dynamo.

The diagram of Fig. 13 differs from that in Fig. 12 only in the addition of the brushes as there shown diagrammatically inside the circle representing the commutator surface and of arrowheads showing the direction of the current, and of diagrammatic representations of the pole faces. These latter are sketched at the very outer edge of the diagram in order not to confuse the rest of the diagram by additional lines. It will be seen that the typical turn (represented by heavy lines), consisting of conductors 1 and 34, as well as five other equally spaced turns (33-66, 65-98, 97-130, 129-162 and 161-2), are not provided with arrowheads. This is because, at the instant considered, these six turns are passing through the position of short-circuit under the six brushes, which are shown resting upon the twelve commutator segments connected to the twelve ends of these six turns. The direction of motion is clockwise, as shown by the large arrow at the centre of the diagram.

Increased familiarity with armature windings may be obtained by constructing so-called "developed" diagrams. A recent suggestion for the arrangement of "developed" diagrams, is that of E. K. Stembridge. In Fig. 14 is shown, arranged in accordance with this method, a diagram of a six-circuit winding with 60 conductors. The winding pitches are given by the formula

$$y = \frac{60}{6} \pm 1$$

Whence

$$y_f = 9$$
$$y_b = 11$$

In a diagram drawn according to the Stembridge method, the two ends of the armature are shown exactly the same size with the end connections precisely as they might appear on the actual armature. The cylindrical surface is shown "developed" or rolled out flat on the paper, between the two end drawings, and the conductors are shown joined to their end connections by thin lines, which, of course, unlike the other lines, do not represent any part of the winding on the actual armature. The advantages claimed for this method of representing windings relate to its simplicity, the readiness with which it may be drawn to scale and to the fact that the end drawings appear precisely as the ends of the actual armature. We have further added in Fig. 14, the six poles of the machine in their correct positions relative to one another, and have shaded these in two directions to represent respectively the N poles and the S poles. As will be seen, this diagram permits of the poles being drawn in a true position with respect to the armature conductors, and the shaded areas may be regarded as developed surfaces of the pole faces.

The above stated reasons render this method of drawing advantageous for those whose knowledge of armature windings is very elementary, but to one accustomed to winding diagrams, the ordinary diagrams as in Figs. 11, 12 and 13 present the conditions sufficiently closely, and may be more quickly drawn.

Moreover, the drawing of the connecting lines between the conductors and ends in Fig. 14 is a rather long process, and these lines have no counterpart on the actual armature.

(To be continued.)

The List of Questions for the 1907 Question Box of the National Electric Light Association.

Paul Lüpke, editor of the Question Box for the 1907 convention of the National Electric Light Association, has published forty-six pages of questions. It is important that as many answers as possible be sent to Mr. Lüpke, at 222 East State street, Trenton, N. J., within a short time, so that these may be properly classified and put in shape for easy reference at the convention of the association, which will be held at the New Willard Hotel, Washington, D. C., June 4, 5, 6 and 7.

Coal-Testing Plant in Denver.

Dr. J. A. Holmes, of the United States Geological Survey, has concluded negotiations for the land upon which a government coal-testing plant will be constructed in Denver, Col. The Chamber of Commerce of that city agrees to furnish the land. A completely equipped laboratory, with special apparatus for the treatment of coal and its by-products, will be built.

Data Concerning the Arc Furnace.

The University of Wisconsin has issued as bulletin No. 145 of the Engineering Series the thesis presented by Oliver Patterson Watts for the degree of doctor of philosophy. This is entitled "An Investigation of the Borides and Silicides." In his work Dr. Watts made excellent use of an electric arc furnace, and records the following observations:

The longest arcs obtained were six and one-half to five and eleven-sixteenths inches at 104 volts, the former at 800 amperes. At the usual voltage of eighty on the furnace terminals the length of arc at 600 amperes varied from two and three-eighths to three inches. The resistance of the arc depends upon its length, the current strength and the temperature of the furnace, and also the quantity and nature of the vapors within the furnace. An increase of current increases the cross-section of the arc and a rise in temperature decreases the resistance, making it necessary to lengthen the arc in order to maintain the current constant. As a cold charge is fed into a hot furnace, the current decreases. An increase in the amount of vapors of sodium and silicon lowers the resistance.

In an experiment it was attempted to maintain the length of arc unchanged while decreasing the current by means of an external resistance. It was found that the resistance of the arc increased at the same time, and the following conclusion is drawn: "The arc tends to maintain a constant ratio between its own resistance and that of the remainder of the circuit, or in an arc of fixed length tends to maintain a constant voltage."

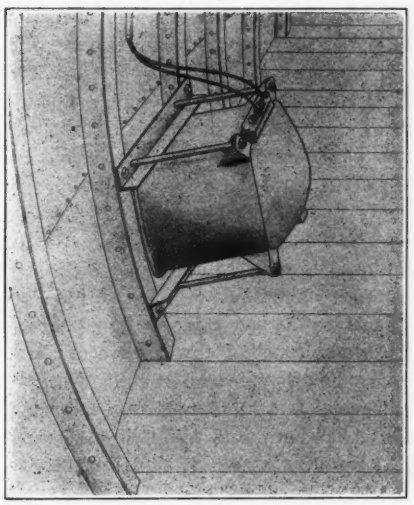
On several occasions a peculiar phenomenon was noticed: The carbon electrodes burned away irregularly, so that they interlocked. Alternating current was used and two separate arcs were formed, each half of the current wave passing across one part of the gap only. The points of the electrodes were coated with smooth, lustrous graphite of extremely fine vein. When using direct current the electrode losses were due to the following causes: Volatilization from the crater, which was confined to the anode; oxidation and disintegration. The first of these is independent of the length of arc, while the latter two depend upon it. The total loss is diminished by fifty per cent by filling the furnace with illuminating gas. This diminishes only the oxidation and disintegration. The losses taking place in two-inch electrodes were double those with one and one-half-inch electrodes. This shows that the smallest possible electrode should be employed.

Submarine Signaling.

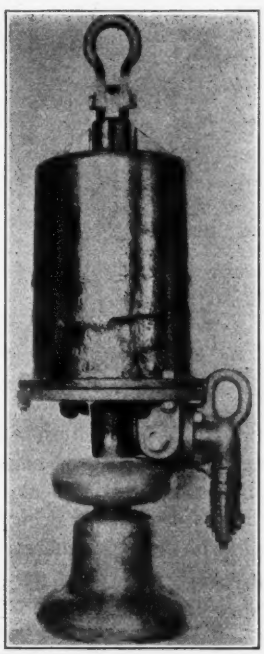
By Henry R. Gilson.

THE earliest records of experiments on the transmission of sound in water are those of Colladon and Sturm, early in the nineteenth century. These experiments, text books relate, were conducted solely for determining the speed of sound in fresh water. There are no records of attempts to utilize sound in water for signaling purposes. Later, various inventors in England and France conducted crude laboratory experiments in water-signaling and made various theoretical assertions in certain patent papers which are still in existence; but they also failed to realize this important invention and made no attempt to obtain a practical application.

In 1880 Professor Lucien I. Blake, while a student of physics in Berlin, had his attention called to the experiments of Colladon and he immediately conceived the idea that, if a system of signaling in water could be worked out on a practical and commercial basis, it would perhaps solve some of the problems which, because of the misleading character of air signaling, have always given trouble to the lighthouse establishments of different countries. Knowing that sound-travel in a varying medium like the air could never be depended upon in fogs, storms, etc., he figured that the water, being practically homogeneous, would do away with all the difficulties experienced in the air, provided a sound could be successfully produced therein, carried to a sufficient distance and there picked up and recorded by the necessary instruments. To his credit it may be said that his general plans, stated in a paper which he read before the American Association for the Advancement of Science, Columbia College, N. Y., 1887, are practically those which have been followed out in the present development of the system, *viz.*: "A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or night, a code of signals would be produced by it which would be transmitted in all directions through the water, with a velocity four to five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus which would take up out of the water the signals arriving from neighboring vessels. For steamships, the sound-producing apparatus was designed to be a steam foghorn or whistle, specially constructed to sound under water. Bell buoys were to have a second bell added under water, while lightships, lighthouses and any headlands might also be provided with submerged bells, which could be rung from the shore when necessary. The sound-receiving apparatus with which each vessel was to be equipped was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel."



SOUND WAVE DETECTOR IN TANK ATTACHED TO SIDE OF SHIP.



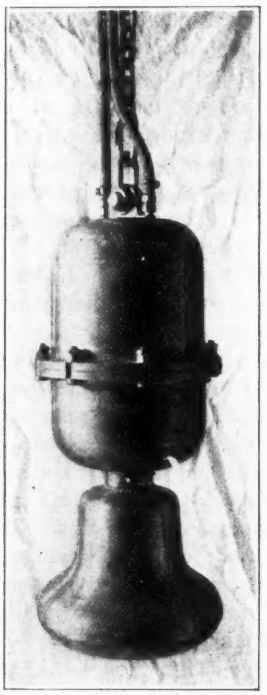
ELECTRIC SUBMARINE BELL.

Professor Blake's experiments covered a period of several years and were conducted as opportunity permitted. They brought to light many things, among them being the fact that a sound produced under water would penetrate the sides of a ship several miles away and could be picked up by receivers inside of the ship and attached to the ship's side below the water line; that it would traverse the tortuous windings of a river for a considerable distance; and that climatic conditions, currents and tides made no appreciable difference upon the sound wave. His work attracted the attention of the United States Lighthouse Board, and facilities of every kind were extended to him. In 1894, assisted by A. B. Johnson, chief clerk of the board, and one who was familiar with all the vagaries of air signals, Professor Blake made a long series of experiments at the Portsmouth, N. H., navy yard. These continued until the outbreak of the Spanish War.

At this time, Arthur J. Mundy, of Boston, who was totally unacquainted with the experiments performed by Professor Blake, and who shared the general fear concerning the Spanish war vessels, originated the idea that by some means or other it ought to be possible to detect their approach at night or in a fog by listening through the water. He placed his plans before Professor Elisha Gray, of Chicago, and formed a syndicate which took up the work of submarine signaling. He was instrumental in bringing about the formation of the Gray Telephone Company which succeeded the syndicate, and was one of the prime movers in the organization of the Submarine Signal Company, the successor to the Gray Telephone Company. Many experiments were made with sound transmitters and submerged bells and many discoveries of moment were unearthed, and to Mr. Mundy belongs the credit of finding the key to the reception of sound aboard ships. In his laboratory he found that if a tumbler filled with a solution was placed inside and against an empty iron kettle floating in a tank of water, sound in the water could readily be taken out of the solution in the tumbler by means of a microphone immersed therein, although the same microphone placed against the side of the kettle collected very much less sound. A successful submarine microphone was devised by Mr.

Mundy, as the ordinary telephone transmitter would not work under water. With this, submarine sounds were heard at a distance of several miles. A long step in advance was thus made, as Professor Gray had just completed the construction of an electrically struck submarine bell. In 1902, when success seemed close at hand, Professor Gray died, and a few months later Mr. Mundy, because of broken health, was forced to give up all experiments.

On his restoration to health, Mr. Mundy again took up the work. Numerous inventions were made by persons connected with the company (notably by Messrs. J. B. Millet and Edward C. Wood) as the result of long and elaborate

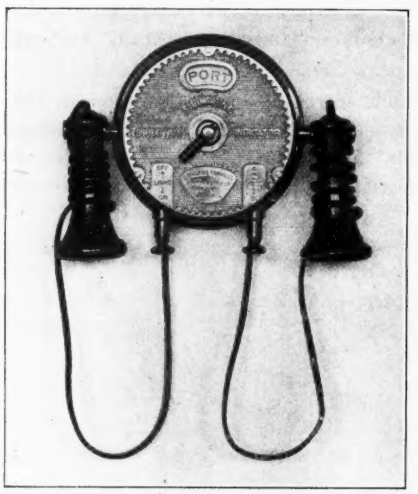


Diaphragm Striker—Closed.

experimentation in the actual working of the apparatus; so that there is no phase of the subject which has not received study. To-day the company has a long file of patents covering the future development of submarine signaling.

In the case of the lightship bell, various striking devices were tried, *viz.:* hydraulic, steam and pneumatic. The standard form of bell is operated by compressed air and rings the number of the ship upon which it is placed. This is suspended from the side of the lightship about twenty feet below the surface, and compressed air is supplied through a heavy rubber tube running from the compressor to the bell. The apparatus is automatic, and, requiring little attention, has found favor with lightship crews. These bells have been heard up to eighteen miles and emit a very clear, high-pitched, distinguishable note. They are rung at the rate of about forty blows per minute.

As all dangerous shoals and coasts are not indicated by lightships, it has been found necessary to submerge a bell by means of fastening it to the bottom of a buoy suitably anchored, and of utilizing the power of the waves for ringing the bell. Owing to the tremendous size of the waves, it is necessary to build the apparatus of exceeding strength. The principle upon which it works is simple, and consists in placing a body in stable equilibrium twenty feet below the surface, telescopically attached to the buoy. The relative motion between the former and the latter bobbing up and down on the waves is used to generate the power for striking. There are several types of this apparatus, such as a combination air whistle and submarine bell buoy, a combination air and submarine bell buoy, and lastly the most complete automatic marine-signaling device



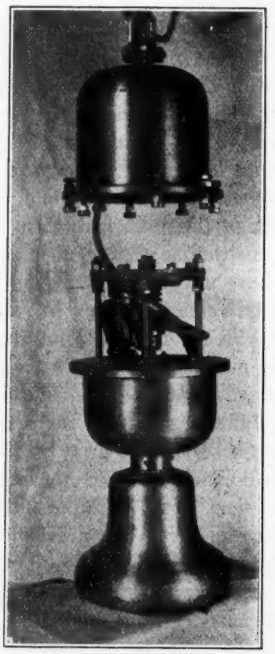
Indicator.

known, the combination whistle and gas buoy which has a submarine bell attached.

Owing to the necessity, in some exposed positions where it is impracticable to place a lightship, for a signal to be sounded in such form that it will indicate to the mariner his position, and owing to the inadvisability of making a submarine bell buoy ring a code, electrically struck bells have been invented. These bells are mounted on tripods placed upon the bottom of the ocean and connected by electric cable to the power station on shore. They can be made to strike any code desired.

The sound-receiving apparatus consists of two tanks filled with liquid and clamped against the skin of the ship below the water line, as shown herewith, one on the port and one on the starboard side. Two specially constructed microphones of the granular type are placed in each tank with wires leading up to the direction indicator in the pilot-house. The direction indicator is a round metallic case eight inches in diameter fastened to the wall of the pilot-house or wherever desired. By a proper manipulation of the switches one may in turn listen in either the port or the starboard tank and in either microphone that is desired. The sound of the submarine bell miles away passes through the water, through the sides of the ship and is picked up by the microphones in the tanks and thereby transmitted to the receivers shown hanging on the direction indicator.

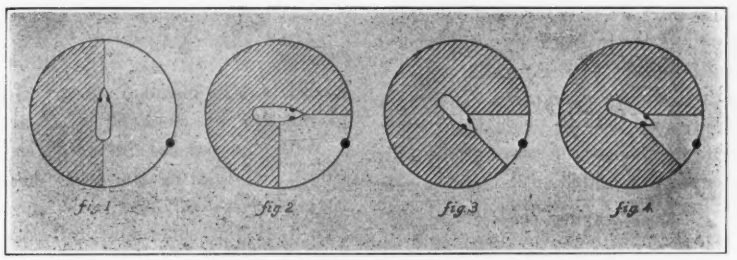
The method of ascertaining the direc-



Diaphragm Striker—Open.

tion from which submarine sounds are coming is as follows: In the diagram the vessel which is receiving the sound is shown in the centre. The dots in the bow represent the port and starboard ears, while the submarine bell is indicated by the dot in the circumference of the circle. Fig. 1 shows the ship heading north when first observation is taken. The fainter sound heard on the port side of the ship proves that the bell must be somewhere on the starboard side, where the sound is relatively louder; therefore half the circle is shaded to indicate that it does not contain the bell. The ship now turns to starboard ninety degrees, heading east, and the fainter sound being still on the port side, the shading is ex-

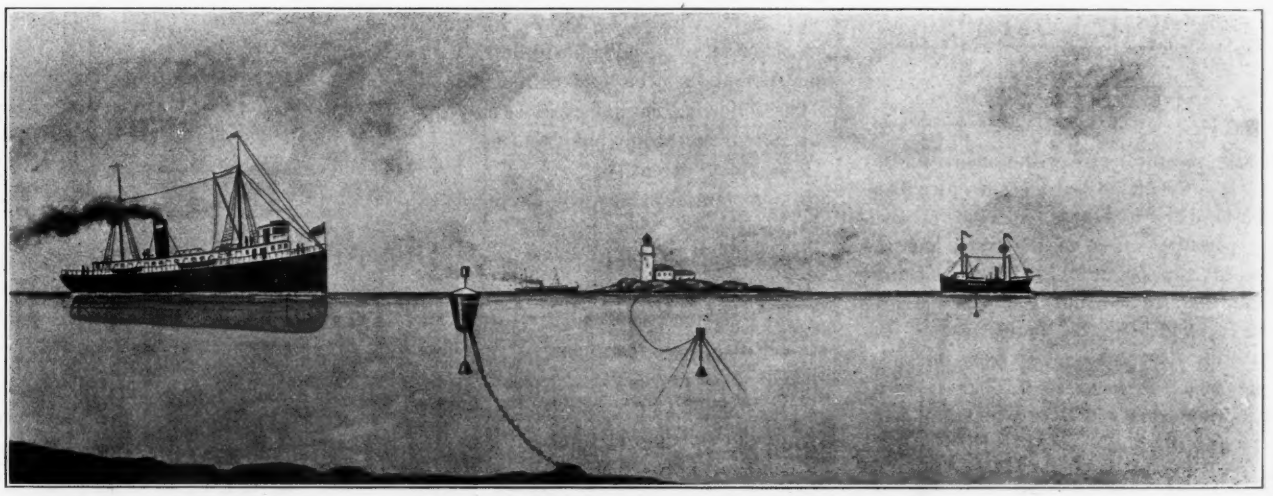
tended, leaving only one-quarter of the circle to explore. The ship now turns forty-five degrees, heading southeast, and the fainter sound is now heard on the starboard side, and the shading is again extended, thus showing that the bell is somewhere between east and southeast. Turning the ship back twenty-two and one-half degrees, the bell is heard equally well on both sides, thus indicating that it is dead ahead. As the ship sails toward the bell the sound steadily grows louder, thus confirming previous observations. With a little practice it is possible to ascertain the location of the bell within one-quarter of a point of the compass. This is being done constantly, and even more accurate locations have been found.



METHOD OF DETECTING POSITION OF SUBMARINE BELL.

collisions at sea, which has been so frequent and disastrous in the past. A bell is suspended in the fore-peak tank of each ship. This is rung by power, either hand or otherwise, and the sound passing through the sides of the ship and through the water is picked up by the ears of the approaching vessel. The latter, by varying her course so as to bring the sound a little louder in the port or starboard receiver, will thus pass by on the corresponding side of the boat which she is approaching.

The use of the submarine signal in time of war will prove invaluable, as by it submarine boats may communicate with one another, or a battleship may direct the movements of her deployed submarines. The approach of an enemy may be detected when miles away by hearing the sound of the engines.



SKETCH SHOWING ARRANGEMENTS OF SUBMARINE BELLS.

In its practical application, the submarine signal is a factor of the greatest importance. The fisherman in his dory need no longer fear fog, provided he has a small hand-operated bell to suspend over the side, for the schooner, equipped with ears, can hear the signal, locate its direction, and is able to pick up its boats without difficulty.

Of paramount importance is the fact that the use of this invention will prevent

Submarine bells are now established in United States, British, German, French, Canadian, Dutch and Danish waters; and vessels of the commercial marine having a combined tonnage of over one million tons are equipped to receive submarine signals. The list includes all the important transatlantic steamships, many coastwise lines, as well as yachts, tugs and schooners. The King of England and the Emperor of Germany have their yachts equipped to receive submarine signals; and the British Admiralty report on the system is the most exhaustive as well as the most laudatory treatment the subject has received. The endurance and experience tests of the United States Lighthouse Board were no less satisfactory; and as a result the Atlantic coast lightships are now operating the signals.

An immense field of possible usefulness is thus opened up, and where it will end and what the future contains for us along this line only the years will tell.

The Establishment of a Historical Museum in the Engineering Societies' Building.

The board of directors of the American Institute of Electrical Engineers passed the following resolutions at its meeting on January 25:

"*Resolved,* That the library committee is hereby authorized to accept, on behalf of the Institute, donations of original apparatus, models, photographs, manuscripts, printed documents and similar exhibits suitable for a museum of historical electrical material; also to accept the loan of material of the same general character which can not be secured by gift.

"*Resolved,* That each donation or loan accepted under the foregoing resolution shall be acknowledged by the chairman of the library committee, specifying the articles received in sufficient detail to insure subsequent identification and reciting the conditions of gift or loan and acceptance."

SOME THEORETICAL NOTES ON THE REDUCTION OF EARTH CURRENTS FROM ELECTRIC RAILWAY SYSTEMS BY MEANS OF NEGATIVE FEEDERS.[1]

BY GEORGE I. RHODES.

The subject of earth currents caused by electric railway systems is of such importance that it is believed a few theoretical notes on the relative efficiencies of different return feeder systems in reducing stray currents will not be without interest.

Consider any system, the potential of whose running rails may be represented by the Curve I, Fig. 2, which is plotted with distances from the power-house or substation as abscissas, and potentials of the rails referred to the negative bus-bar as ordinates. Assume for the time being that all resistance offered to current flowing from the tracks to earth is in the contact between rails and earth.

Let a = contact resistance per foot between rails and earth.

l = distance from power station.

v = potential of rails referred to negative bus-bar.

I_a = total leakage current.

Now if the negative bus-bar is completely grounded, and the earth of uniform potential, as would be the case if it had zero resistance,

$$\Delta I_g = \frac{v \Delta l}{a}$$

$$I_g = \sum \frac{v \Delta l}{a}$$

If a is uniform over the entire line, it is evident that the leakage current will be measured by the area enclosed between the potential curve of the track and the line of zero potential. If a is not uniform, the area will not be a true measure, but it will still be indicative of the amount of current flowing from the rails.

If now the negative bus-bar is insulated, the earth will have a potential with reference to the bus-bar such that the current flowing out of the rails shall be equal to that flowing into them. Under the assumption of uniform contact resistance between track and ground, this potential will be such that the areas enclosed by the potential curve, above and below the line of earth potential, are equal.

The assumption that the earth is of uniform potential is obviously far from correct, for since its resistance is not zero it is raised to a certain extent by the presence of a grounded conductor of higher potential. If the curve is plotted with reference to the ground in the vicinity of the rails as zero, the area enclosed by the curve will then measure the true leakage current with the above limitations; but if the curve is plotted with reference to the earth at that point where the rails and ground are at the same potential, the area enclosed will not measure the actual leakage, but rather the maximum current that would flow if the earth offered no resistance except at the surface of contact with the rails.

On this latter assumption, then, the following cases will be considered, both with the negative bus-bar thoroughly grounded and insulated. The load is considered to be uniformly distributed over the whole line, which extends in one direction only from the power station.

I. No copper in return circuit.

II. Copper of uniform section bonded to the rails at short intervals.

III. Copper distributed to give uniform drop, bonded to the rails at short intervals.

IV. A single insulated negative feeder connected to rails at middle of the line, and at the power station.

V. A single insulated feeder connecting the rails to the negative bus-bar only at the middle of the line.

VI. Several insulated feeders.

VII. Several insulated feeders with equal potentials at all feed points.

The following notation will be used:

i = current at any point on line.

I = total current.

v = potential at any point referred to bus-bar as zero.

l = distance from power station.

L = total length of line.

r = resistance per foot of return.

$\rho = 10.30\omega$ = resistance per circular mil-foot of copper.

ω = 0.00,000,302 pounds = weight per circular mil-foot of copper.

s_i = equivalent conductivity of track rails in circular mils of copper.

s_c = circular mils of return copper at power station.

W = weight of return copper.

A = area representing leakage current with negative bus-bar grounded.

a = area representing leakage current with negative bus-bar insulated.

I. No return copper.

$$i = I\left(1 - \frac{l}{L}\right)$$

$$r = \frac{\rho}{s_i}$$

$$V = \int i\, r\, dl = \frac{\rho I}{s_i}\left(l - \frac{l^2}{2L}\right)$$

The curve represented by this equation and shown as I in Fig. 2, is a parabola whose axis is parallel to the axis of v and whose apex is at the point

$$l = L \quad v = \frac{\rho I L}{2 s_i}$$

With the bus-bar grounded, the area beneath the curve measures the leakage current, and is,

$$A = \frac{\rho I L^2}{3 s_i}$$

as obtained by means of the usual formula giving the area enclosed by a parabola.

With the bus-bar insulated, it can be shown by equating the areas enclosed by the curve above and below the neutral line that the earth and rail are at the same potential at the point

$$L_o = L\left(1 - \frac{1}{\sqrt{3}}\right)$$

and the area representing leakage current is

$$a = \frac{1}{3\sqrt{3}} \cdot \frac{\rho I L^2}{s_i}$$

II. Return copper of uniform section.

$$i = I\left(1 - \frac{l}{L}\right) \text{ as before}$$

$$r = \frac{\rho}{s_i + s_c}$$

$$v = \frac{\rho I}{s_i + s_c}\left(l - \frac{l^2}{2L}\right)$$

The curve representing this equation when $s_c = s_i$ is shown as Curve D, Fig. 2. It is a parabola as in Case I, but its ordinates bear the ratio $\frac{s_i}{s_i + s_c}$ to those of the first curve.

The area representing leakage current with grounded bus-bar can be shown to be

$$A = \frac{s_i}{s_i + s_c} \cdot \frac{\rho I L^2}{3 s_i}$$

and with the bus-bar insulated the neutral is at

$$L_o = L\left(1 - \frac{1}{\sqrt{3}}\right)$$

making

$$a = \frac{s_i}{3\sqrt{3}\,(s_i + s_c)} \cdot \frac{\rho I L^2}{3 s_i}$$

The weight of copper is

$$W = \omega s_c L$$

III. Copper distributed for uniform drop.

$$i = I\left(1 - \frac{l}{L}\right) \text{ as before}$$

$$r = \frac{\rho}{(s_i + s_c)\left(1 - \frac{l}{L}\right)}$$

[1] A paper presented at the 214th meeting of the American Institute of Electrical Engineers, New York, March 1, 1907.

That is, the conductivity is proportional to the current.

$$v = \frac{\rho\, I\, l}{s_i + s_c}$$ a straight line.

It is evident that this equation can hold only when l is such that

$$(s_i + s_c)\left(1 - \frac{l}{L}\right) = s_i$$

then

$$l = L_1 = L\,\frac{s_c}{s_i + s_c}$$

For values of $l > L_1$, the conductivity is uniform and equal to that of the rail return (see Fig. 1).

From $l = L_1$ to $l = L$

$$i = \frac{L_1 I}{L} - \frac{l}{L}$$

$$r = \frac{l}{s_i}$$

$$v = \frac{\rho\, I}{s_i}\left[\frac{L_1\,(l - L_1)}{L} - \frac{(l - L_1)^2}{2\,L}\right] + \frac{\rho\, I\, L_1}{s_i + s_c}$$

This curve is that portion of the para-

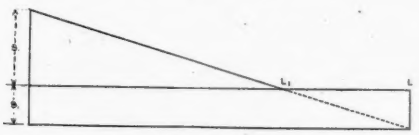


FIG. 1.—DISTRIBUTION OF COPPER FOR UNIFORM DROP.

bola I, Fig. 2, beyond $l = L_1$, dropped until it is tangent to the straight line.

$v = \frac{\rho\, I\, l}{s_i + s_c}$. See III, Fig. 2.

The area representing leakage current with the bus-bar grounded can be shown to be

$$A = \frac{s_i\,(3\,s_c^2 + 6\,s_i\,s_c + 2\,s_i^2)}{2\,(s_i + s_c)^3} \cdot \frac{\rho\, I\, L^2}{3\,s_i}$$

and with the bus-bar insulated the neutral point is at

$$L_o = \frac{L}{2}\left\{1 - \frac{s_i^2}{3\,(s_i + s_c)}\right\}$$

for values of $s_c > 0.815\ s_i$.

This makes

$$a = \frac{s_i\,(3\,s_c^2 + 6\,s_i\,s_c + 2\,s_i^2)^2}{24\,(s_i + s_c)^5} \cdot \frac{\rho\, I\, L^2}{3\,s_i}$$

The weight of copper used is

$$W = \omega\, s_c\, \frac{L_1}{2} = \frac{\omega\, s_c^2\, L}{2\,(s_i + s_c)}$$

In order to compare properly this case with Case II, equal amounts of copper must be used making

$$\frac{s_{c\,iii}^2}{2\,(s_i + s_{c\,iii})} = s_{c\,ii}$$

$$s_{c\,iii} = s_{c\,ii} + \sqrt{s_{c\,ii}^2 + 2\,s_i\,s_{c\,ii}}$$

IV. Single insulated return feeder from middle of line. Connection to rails at power-house.

By the use of Kirchoff's laws it can be shown that

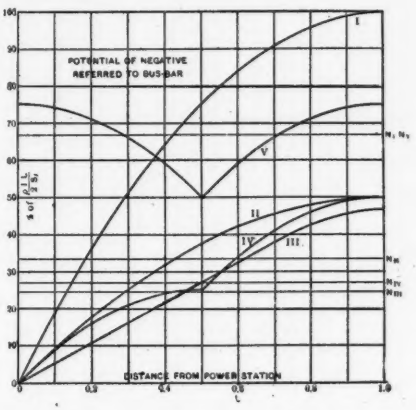


FIG. 2.—POTENTIAL OF NEGATIVE REFERRED TO BUS-BAR.

From $l = o$ to $l = \frac{L}{2}$

$$i = I\left(1 - \frac{3\,s_c}{4\,(s_i + s_c)}\right) - I\,\frac{l}{L}$$

$$r = \frac{\rho}{s_i}$$

$$v = \frac{\rho\, I}{s_i}\left\{ l\left(1 - \frac{3\,s_c}{4\,(s_i + s_c)}\right) - \frac{l^2}{2\,L}\right\}$$

From $l = \frac{L}{2}$ to $l = L$

$$i = \frac{I}{2} - I\left(e - \frac{L}{2}\right)$$

$$v = \frac{\rho\, I}{s_i}\left\{ \frac{\left(l - \frac{L}{2}\right)}{2} - \frac{\left(l - \frac{L}{2}\right)^2}{2\,L} + \frac{L}{2}\left(\frac{3\,s_i}{4\,(s_i + s_c)}\right)\right\}$$

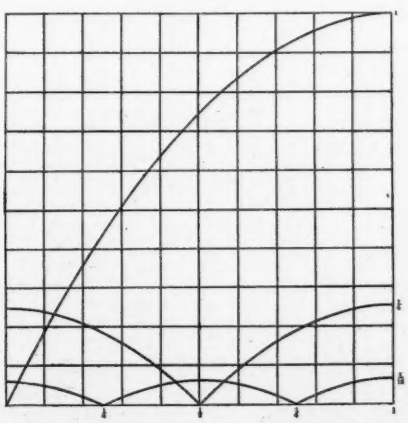


FIG. 3.—POTENTIAL OF NEGATIVE REFERRED TO BUS-BAR—CASE VII.

Both curves are portions of the parabola of Case I (see IV, Fig. 2).

The area representing leakage current can be shown to be

$$A = \left\{1 - \frac{27\,s_c}{32\,(s_i + s_c)}\right\} \frac{\rho\, I\, L^2}{3\,s_i}$$

and with the bus-bar insulated

$$L_0 = L\left\{1 - \frac{1}{\sqrt{3}}\sqrt{1 - \frac{9\,s_c}{16\,(s_i + s_c)}}\right\}$$

making

$$a = \frac{1}{3\sqrt{3}}\left(1 - \frac{9\,s_c}{16\,(s_i + s_c)}\right)^{\frac{3}{2}} \frac{\rho\, I\, L^2}{3\,s_i}$$

The weight of copper used is

$$W = \frac{\omega\, s_c\, L}{2}$$

Making for proper comparison with Cases II and III

$$s_{c\,iv} = 2\,s_{c\,ii}$$

V. A single insulated return feeder from middle of line. No other connection to rail.

It can be shown that from

$$l = o \text{ to } l = \frac{L}{2}$$

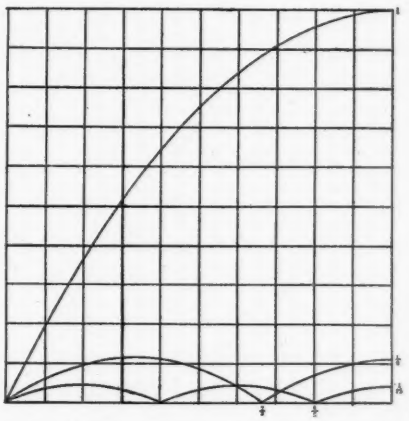


FIG. 4.—POTENTIAL OF NEGATIVE REFERRED TO BUS-BAR.

$$i = -\frac{l\, I}{L}$$

$$v = \rho\, I\, L\left[\frac{1}{2\,s_c} + \frac{1}{8\,s_i}\right] - \frac{\rho\, I\, l^2}{2\,s_i}$$

and from $l = \frac{L}{2}$ to $l = L$

$$i = \frac{I}{2} - \frac{I}{L}\left(\rho - \frac{L}{2}\right)$$

$$v = \frac{\rho^2}{s_i}\left\{ \frac{\left(\rho - \frac{L}{2}\right)}{2} - \frac{\left(\rho = \frac{L}{2}\right)^2}{2\,L} + \frac{L\,s_i}{2\,s_c}\right\}$$

These are two symmetrical portions of the parbola of Case I intersecting at the point $l = \frac{L}{2}$ $v = \frac{\rho\, I\, L}{2\,s_c}$ (see V, Fig. 2).

With the bus-bar grounded the area representing leakage current is

$$A = \frac{6\,s_i + s_c}{4\,s_c} \cdot \frac{\rho\,I\,L^2}{3\,s_i}$$

and with the bus-bar insulated there are two neutral points at

$$L_0 = \frac{L}{2\sqrt{3}} \text{ and } L_0 = \frac{L}{2}\left[1 - \frac{1}{\sqrt{3}}\right]$$

making $a = \frac{1}{12\sqrt{3}} \frac{\rho\,I\,L^2}{3\,s_i}$

The weight of copper is the same as in Case IV.

VI. With several insulated feeders the potential curve will take a form similar to that of Case V in which the curve between any two feeders is a portion of the parabola of Case I. If the feeders are of uniform size, the general form of the potential curve will approach the straight line of Case III as numbers of feeders is increased indefinitely. With a single feeder the area measuring leakage current is larger than for the case with the copper distributed for uniform drop, and with increasing number of feeders this area will approach it as a limit, being always larger.

With feeders graded in size to give uniform potential at the feed points the curves will be of the forms in Case VII.

VII. Several insulated feeders with equal potentials at feed points.

In this case the uniformly equal potentials at the ends of feeders may be secured by properly adjusting the sizes or by means of negative boosters. By adjustment of sizes, the potential of the track must necessarily be greater than that of the bus-bar, and if there is a solid ground at the power station there will be a leakage current due to this difference; but with the use of boosters the potentials at the ends of the feeders can be maintained at uniform with the negative bus-bar, and furthermore, this, with a widely fluctuating load such as is the case on an electric railway.

For the best results with a given number of feeders it is evident that they must be connected to the rails at such points as will give equal maxima on the potential curves. This may be accomplished in two ways, *viz.:*

1. No connection to rails at power station, and distance between feed points twice the distance from the power-house to the first point, and from the last point to the end of the line. (See Fig. 3.)

2. Connection to rails at power-house with the distance between feed points, and from the power station to the first feed point equal to twice the distance from the last point to the end of the line. (See Fig. 4.)

1. With a single feeder and no connection at power-house the feed point for equal maxima will be at the centre of the line (see Fig. 3), the potential curve being made up of the upper portions of the parabola of Case I, also shown in Fig. 3.

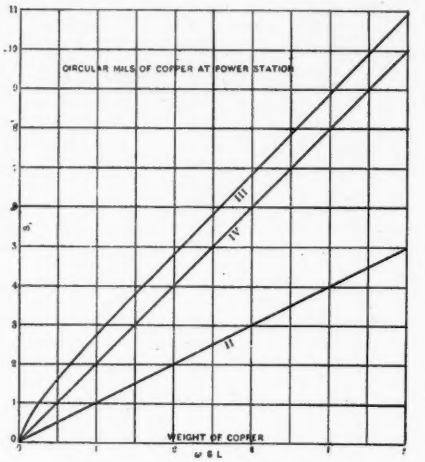


FIG 5.—CIRCULAR MILS OF COPPER AT POWER STATION.

With the bus-bar grounded the area beneath this curve is

$$A = 2 \times \tfrac{2}{3} \times \frac{L}{2} \times \tfrac{1}{4} \frac{\rho\,I\,L}{2\,s_i} = \tfrac{1}{4} \frac{\rho\,I\,L^2}{3\,s_i}$$

With two feeders the feed points will be one-fourth and three-fourths of the distance from the power-house and the area will be

$$A = 4 \times \tfrac{2}{3} \frac{L}{4} \times \tfrac{1}{16} \times \frac{\rho\,I\,L}{2\,s_i} = \tfrac{1}{16} \frac{\rho\,I\,L^2}{3\,s_i}$$

With μ feeders the feed points will be at

$$\frac{1}{2\,\mu}, \frac{3}{2\,\mu} \ldots \frac{2\,\mu - 1}{2\,\mu}$$

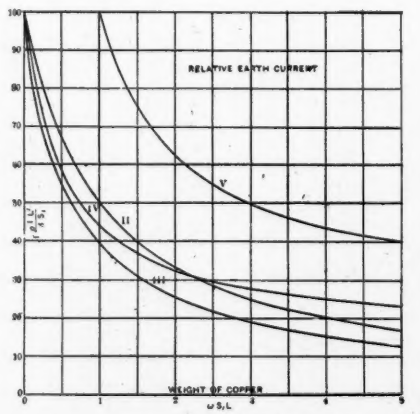


FIG. 6.—RELATIVE EARTH CURRENT.

of the distance from the power-house to the end of the line, making

$$A = 2\,\mu \times \tfrac{2}{3} \times \frac{L}{2\,\mu} \times \frac{1}{(2\,\mu)^2} \times \frac{\rho\,I\,L}{2\,s_i} = \frac{1}{4\,\mu^2} \frac{\rho\,I\,L^2}{3\,s_i}$$

2. With one feeder the point of connection to the rails will be at $l = \frac{2}{3}$ L, making

$$A = 3 \times \tfrac{2}{3} \times \frac{L}{3} \times \frac{1}{(3)^2} \times \frac{\rho\,I\,L}{2\,s_i} = \frac{1}{9} \frac{\rho\,I\,L^2}{3 s_i}$$

With two feeders the points of connection will be at $l = \frac{2}{5}$ L, and L, making

$$A = 5 \times \tfrac{2}{3} \times \frac{L}{5} \times \frac{1}{(5)^2} \times \frac{\rho\,I\,L}{2\,s_i} = \frac{1}{25} \frac{\rho\,I\,L}{3\,s_i}$$

With μ feeders the feed points will be at

$$l = \frac{2}{2\,\mu + 1} L, \frac{4}{2\,\mu + 1} L \ldots \frac{2\,\mu}{2\,\mu + 1}$$

making

$$A = (2\,\mu + 1) \times \tfrac{2}{3} \times \frac{L}{(2\,\mu + 1)} \times \frac{1}{(2\,\mu + 1)^2} \frac{\rho\,I\,L}{2\,s_i} = \frac{1}{(2\,\mu + 1)^2} \frac{\rho\,I\,L}{3\,s_i} = \frac{1}{4\,(\mu + \frac{1}{2})^2} \frac{\rho\,I\,L^2}{3\,s_i}$$

Thus it is evident that making a connection to the bus-bar in addition to using feeders has the effect in the equation

$$A = \frac{1}{2\,\mu^2} \frac{\rho\,I\,L^2}{3\,s_i}$$

of increasing the number by one-half a feeder. This will explain the points as the curve in Fig. 8 of one-half, one and one-half, two and one-half feeders, etc.

If the bus-bar is insulated the equation for area representing leakage current is

$$a = \frac{1}{12\sqrt{3}\,\mu^2} \frac{\rho\,I\,L^2}{3\,s_i}$$

In the case of insulated feeders with negative boosters the leakage current from rails to ground is entirely independent of the amount of copper used, and the size of feeders is determined solely by the cost of power necessary to run the boosters.

Having now found equations representing the leakage currents for the different cases, let us now compare them. Fig. 5 gives the cross-section of the copper at the power station in the several cases, to give equal weights of copper, the unit of weight being $\omega\,s_i$ L, or a weight of copper of length L which gives a conductivity equal to that of the rails.

Fig. 6 gives the relative leakage currents for the several cases (in which the bus-bar is grounded) plotted to amount of copper used. The unit of leakage current is taken as that which occurs on a line without negative copper in which the bus-bar is grounded.

Fig. 7 gives the relative leakage currents with the bus-bar insulated.

Fig. 8 gives the relative leakage currents for Case VII with bus-bars insulated, plotted with the number of feeders as abscissas, the points representing half feeders being as explained above.

It is at once apparent that insulating the negative bus-bar very much decreases the leakage current in all cases, the decrease being in the neighborhood of eighty per cent. Further than this, it is unnecessary to consider the case of a solid ground at the power station. With the bus-bar insulated, it is seen that the leakage currents with the copper either uniformly distributed or distributed for uniform drop, are identical. The equations do not represent the same line, but they coincide so nearly that the curves are identical within a very few per cent.

With a single feeder to the middle of the line and a connection to the bus-bar at the power station, it is seen that the results are poorer than for any other method for large feeders, the divergency becoming greater as the amount of copper is increased, but with a single feeder and no other connection between bus-bar or rails, the leakage is independent of the amount of copper used and equal to 4.8 per cent of the original leakage with the bus grounded and no copper in the negative circuit.

This latter is really covered by Case VII. The great superiority of the boosted negative feeder method of reducing leakage from the rails is at once apparent, two feeders reducing the leakage to 1.2 per cent of its original value with the bus-bar grounded, or about 6.2 per cent of its original value with the bus-bar insulated. Very little is gained by using more than two feeders.

In conclusion, a few figures as to the amount of copper required to reduce the leakage to one-half with the bus grounded may be of interest. Let us consider a double-track road with 100-pound rails. The equivalent conductivity of each rail is about 1,200,000 circular mils of copper if well bonded, making $s_l = 4{,}800{,}000$.

If the copper is to be of uniform section, 4,800,000 circular mils must be used the entire length of the line.

If the copper is to be distributed to best advantage it must be of a section 9,120,000 circular mils at the power station, being reduced uniformly to zero at a point 65.5 per cent of the distance to the end of the line. The total amount of copper used will be sixty-two per cent of that in the first case.

If an insulated feeder to the centre of the line is used, with a connection at the power-house it must of a section 7,200,000 circular mils, making the weight of

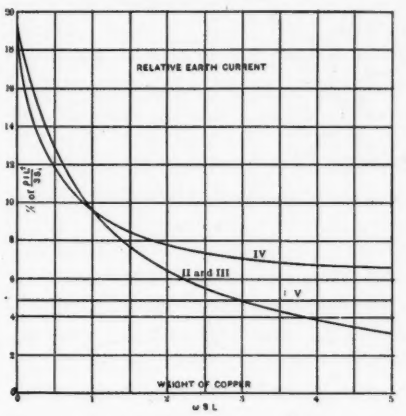


FIG. 7.—RELATIVE EARTH CURRENT. NEGATIVE BUS-BAR INSULATED.

copper seventy-five per cent of that in the first case.

If the bus-bar is now insulated the 4,800,000 circular mils of copper extending the entire length of the line will reduce the leakage to 9.7 per cent; sixty-two per cent of this copper distributed to best advantage will reduce the leakage twelve per cent; while a single feeder with a connection at the power-house, using seventy-five per cent of the copper will reduce it to 10.4 per cent. Using a weight of copper determined only by its carrying capacity and the cost of power, in two

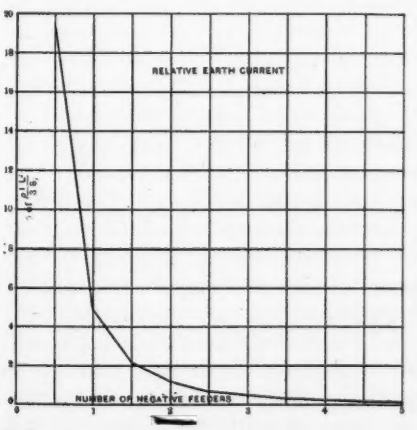


FIG. 8.—RELATIVE EARTH CURRENT. BUS-BAR INSULATED—CASE VII.

boosted feeders, will reduce the leakage to 1.2 per cent with no connection at the power-house, and by using twenty per cent larger feeders, to 0.77 per cent with such a connection.

Progress on the Pennsylvania Tunnels.

Now that a period of favorable weather conditions has begun, work on the Pennsylvania Railroad's New York terminal and tunnels is going forward with great rapidity. A considerable section of the tunneling is actually completed. There has been another "meeting" of tunnels—this time in Long Island City. The southernmost of the four tubes being driven from East avenue under the Long Island Railroad passenger terminal toward the East river has reached the river shaft and is now connected with the tubes that go out under the water.

About a week ago the "headings" bound in opposite directions under Thirty-second street, Manhattan, came together nearly under Third avenue, so that there are continuous passages from the East river to Fifth avenue under both Thirty-second and Thirty-third streets.

Under the East river the cast-iron tubes, bound in both directions, have gone about 500 yards. Those going east from Manhattan, having started a full year earlier, are more advanced. The three to the south, known as B, C and D, are now piercing through the rock of Blackwell's Island reef. The tubes bound from the Long Island City side toward Manhattan are about 350 feet out under the water. The meeting of the eastbound and westbound tubes will take place considerably to the east of the middle of the river.

The work under the East river recently has been more satisfactory in every respect than it was in the earlier stages.

About eighty-five per cent of the excavation work in the area bounded by Seventh and Ninth avenues and Thirty-first and Thirty-second streets is done. Between Seventh and Eighth avenues practically all the excavation is completed. The greater part of the steel work which is to support Eighth avenue as a bridge over the underground tracks is in place. The foundations for the station columns are being laid.

On the Jersey side, between Harrison, on the present main line of the Pennsylvania, and the Bergen Hill tunnels, several bridges have been constructed. The one over the Hackensack river is nearly finished. Under Bergen Hill itself, through the hard Palisades rock, the tunnelers are making more rapid progress than at any previous time. They are now at work in four sets of "headings"—west from the Weehawken shaft, east from the Hackensack portal on the edge of the meadows, and east and west from the central shaft, 220 feet beneath the crest of the hill.

THE LAWS OF RADIATION.

AN ADDRESS BY PROFESSOR O. LUMMER BEFORE THE NEW YORK SECTION OF THE ILLUMINATING ENGINEERING SOCIETY.

A special meeting of the New York section of the Illuminating Engineering Society was held on Friday, March 22, at the Engineering Societies' Building, New York city, to hear an address by Professor Otto Lummer, of the University of Breslau. Dr. Lummer has been in this country delivering a series of addresses at Columbia University, and kindly agreed to address the society before leaving for Europe.

The speaker was introduced by President Sharp, who said that the lecturer, now a professor at the University of Breslau, had been formerly connected with the Physikalischer Technischer Reichsanstalt, and was distinguished as the inventor of the Lummer-Brodhun photometer, the most delicate of all photometers; but his chief fame rested upon the more important work of investigating radiation and deducing the laws governing it. He had shown that Wien's law was incorrect, and had replaced it by one that is exact.

Dr. Lummer opened the address by some general remarks on the study of physical science, pointing out that we can never determine the cause of such actions, though we may classify the phenomena and deduce the laws. In the Middle Ages the study of physical phenomena was looked upon as almost degrading, but such has been the progress of civilization that to-day, instead of blind idolatry, we have unbounded admiration shown by all for Nature. Although we can not know much about the real forces, we can know the laws. We may be sure that these are laws, and we reach these conclusions by asking questions. An anecdote relating to Helmholtz was told. His father ridiculed the young man's love for science and endeavored to lead him into other lines of work. This prejudiced feeling existed for many years, in fact until the son was famous throughout the world, had an income much greater than his father, and was acknowledged by the scientific world as one of its leaders. Then the old man's opinion shifted.

Dr. Lummer, in speaking of the study of physical science, described the enviable position occupied by professors in Germany. They are unaffected by governmental changes, are independent, and, in fact, kings in their own realm. He then passed to the subject of the discussion—the laws of radiation.

Taking up Kirchoff's work, he gave the general formulæ connecting radiation with temperature and wave-length, but pointed out that, although this investigator had such a deep insight into the subject, he had not devised any method for checking the laws; in fact, although he expressly stated that bodies within an enclosure must be at the same temperature and must radiate equally, and therefore all have the same brilliancy and appearance, it was left to Dr. Lummer himself to find the way, or, as he put it, to punch a hole in the cavity in order to determine, by means of a bolometer or other instrument for measuring radiation, the amount of radiation sent out from each unit of surface. In other words, all bodies within the cavity radiate as though they were true black bodies. Another method of obtaining the same result is to place a perfect mirror in front of the radiating body. A beam of light falling at an angle upon the body is partially absorbed, the part which is reflected is returned again by the mirror, until eventually all is taken up, and there is total absorption and hence, inversely, there must, under these conditions, be black-body radiation. Boltzman's law, which connects total radiation and temperature, was explained, and the results of the experimental investigation were given. These enable the constants involved in the equation to be deduced, so that, by measuring the radiation from any body, it becomes possible to deduce the so-called black-body temperature. This is assuming radiation as a black body, and represents the lower temperature limit. To determine the upper, the most perfect reflector known—pure platinum—may be taken, the radiation from it measured, the constant determined, and thus enable the temperature of a body to be computed by measuring the radiation, assuming it behaves as the most perfect reflector. The true temperature lies between these limits.

Knowing these two constants, from the thermodynamic theory of gases, it becomes possible to compute the number of molecules in a cubic centimetre of an ideal gas, and the results thus obtained are in good agreement with those given by other methods. It is now certain that these laws of radiation are true laws of Nature, as much so as Newton's law of gravitation.

These investigations have led to other results. Maxwell's electromagnetic theory indicates that there should be a repulsion set up by radiant energy. The laws of radiation explain this effect, and thus show that this repulsion must be dealt with as a new factor in scientific research, particularly affecting astronomy. In fact, this new factor explains certain astronomical facts which have hitherto been not understood. The laws show that the ratio of repulsion to attraction increases as the individual particles decrease in size, until they are about one-thousandth of a millimetre in diameter. At this point the two forces are balanced. As the diameter decreases, the repulsion overcomes the attraction, and as the size still further decreases, the ratio changes again until, at a diameter of about one-ten-thousandth of a millimetre, the attraction again becomes the greater. This effect explains comets' tails, which always point away from the sun, and the dispersion caused by the repulsion accounts for the disappearance of certain famous comets.

Another result has come about from the study of radiation—that is, a change in our conception of the sun. Observations of the sun seem to show a solid or liquid body surrounded by incandescent vapors. This it is now thought is an optical illusion; there is no sharp dividing line; in fact, there can be no such line under the conditions existing in the sun. The sun itself must consist of an incandescent mass, densest at the centre, decreasing in density as the distance from the centre increases, and finally fading away; in fact, it is possible that the sun itself really reaches to the earth.

A determination of the temperature of the sun has been made, but results vary according to the assumptions made. Assuming a black-body radiation, the temperature is something over 5,000 degrees. Different results will be given by other assumptions, and there is no evidence that the radiation is that of a black body. It seems safe to assume, however, that the temperature of the sun may be put at 7,000 degrees. It is immaterial whether the scale used be Fahrenheit, centigrade or absolute.

Taking up the question of more immediate interest to the society—the production of light—it was pointed out that since the earliest days, in Babylon, Nineveh and other of the old cities, certain of the streets were lighted brilliantly by means of lamps. In some cities these were vessels containing about 100 pounds of fat and having a wick three inches in diameter. The earliest source of light was, of course, the fire, and this is used by various peoples even down to this time. The first great step in illumination was

the recognized necessity of separating light from heat. The old Roman lamp and the candle of the Middle Ages were results of this endeavor, yet great as our advance has been since then, relatively speaking we are not much better off than the Romans.

In determining the value of a lamp, some arbitrary method must be adopted. It may be rated according to its physical perfection, or according to the cost as a light-producer. Its physical perfection may be measured by determining the ratio of radiation within the luminous range to the total radiation. It was pointed out, in this connection, that the fact that the human eye is most sensitive to that wave-length of light which represents the maximum energy radiation from the sun was not a mere coincidence. The two facts must be connected together in some way through Darwin's generalization.

In classifying lights two divisions are made—lights which are luminescent and those in which the effect depends upon temperature. In an incandescent body—that is, one which is radiating on account of its temperature—the atoms themselves are vibrating, and, as a consequence, set up vibrations of their electrons, which latter vibrations set up radiations known as light. In luminescent bodies, on the other hand, the light is not produced by vibrations of the atoms, but by vibrations of the electrons alone. The atom may be considered as a beehive. In the first case incandescence due to temperature is similar to shaking the entire hive, and thus disturbing the bees. Luminescence, on the other hand, corresponds to an excitation of the bees without affecting the hive; or, as another simile, luminescence corresponds to the ringing of the bells in a belfry, incandescence to shaking the belfry in order to ring the bells. The world, as we know it, is made up of ordinary mass, electrons and ether. Light is a vibration of the ether, to produce which we should set the electrons in vibration without disturbing the mass. The atoms, as usually considered in chemistry, may not be true atoms, and where the world stops for the chemist, a new world begins for the physicist. Chemistry is, in fact, a rough science.

To obtain light, a method of setting the electrons in vibration must be found. This may be done—in fact, is done—in the Geissler tube. Heat is not an accompaniment of Roentgen rays. However, thus far most progress in producing light has been in the direction of raising the temperature; in fact, it is thought that the efficiency of all the new incandescent lamps is to be attributed to this action. The newer filaments are merely bodies capable of being used at a higher temperature than the ordinary carbon filament. Much advance may be made in this direction, although it can not be compared with the progress which might be made were it in the direction of producing luminescence; in fact, it is probable that the sensation produced by one candle-power could be produced by means of luminescence with an amount of energy about one-millionth of that now necessary. The first one to devise a means of doing this should surely become a millionaire, or rather a billionaire.

Raising the temperature, however, is a relatively effective means of increasing the efficiency, for the energy radiated is proportional to the twelfth power of the temperature of the source; hence if the temperatures are in the ratio of one, two and three, the energies radiated will be in the proportion of one to 4,000 to 600,000. In fact, by raising the temperature of an incandescent lamp, which is about 2,200 degrees, 100 degrees higher, the brilliancy is doubled. It is strange that some one has not before adopted this method of increasing the efficiency of lumination. It would be better to use lamps in this way, even though they last but 300 hours, as compared with a life of 1,000 hours at the normal temperature.

As regards luminescent sources, the greatest advance has been in the production of the mercury vapor lamp invented by Arons, and reduced to practical form by Cooper Hewitt. Yet even this lamp is not much better absolutely than the lamps of the Ancients. It is hard to say this, but it is true.

The arc lamp stands at the head of the list as an incandescent radiator. The temperature of the crater is about 4,000 degrees. Unfortunately, carbon is not a good radiator of light, as too much of the energy is given off as heat. A method of overcoming this has been suggested; for example, by surrounding the radiating body with a body that will let through only the luminous rays and defract the longer wave-lengths. No method of doing this has yet been found, but there may be, and probably are, substances which will accomplish it. As regards an incandescent radiator—that is, one depending upon temperature—there is no need of going above the temperature of the sun—that is, 7,000 degrees—for by doing so the efficiency of the radiator will again begin to fall, since the percentage of radiation in the ultra-violet rays will increase.

Dr. Lummer concluded his address by a few words of appreciation of his pleasure in visiting this country and in addressing the society.

The discussion was opened by Dr. C. P. Steinmetz, who said that the address had been so lucid and so much to the point that there was nothing in it to discuss. He wished, however, to emphasize the distinction made between selective radiation and luminescence. Luminescence is due to vibration of the electrons, and is not a temperature effect, and may exist even though the body be at the absolute temperature. Selective radiation, on the other hand, is a temperature effect, and it simply means that the body is not radiating according to the black-body law. At a given temperature selective radiation always represents a total radiation less than that of the black body. The maximum point of the wave, however, coincides with the black-body law.

Dr. Lummer, in reply, said that the distinction was correct. The term "selective radiation" should not be used for luminescence. It is limited to a temperature effect. Luminescence, as he had already pointed out, is not a temperature effect; it is due to a vibration of the electrons alone, not to a vibration of the atom, which is the result of its temperature. The radiators which do not follow exactly the black-body law are known as gray bodies.

Dr. Samuel Sheldon said that Dr. Lummer stated that we now know nothing about luminescence. He asked whether it was not true that luminescence is always accompanied by a chemical change. By such a change he meant some change in the molecule, corresponding, for example, to a formation of ozone.

Dr. Lummer did not think so, though he could not say, but he made the point that, to him, an atom is simply a body which has a distinctive spectrum. There are as many elements as there are spectra. In this sense there may be such chemical change.

Replying to a question whether some absolute means of measuring light may not be devised, Dr. Lummer said that he did not think so; that the only measure of light is the eye, and unless the instrument could be introduced into the retina and adjusted to measure the effect there, whatever it be, whether electric current or not, no such means can be devised; that the sensation of light is a physiological action which can not be measured absolutely. In his laboratory, however,

he is having conducted an investigation to determine the ratios of the sensations produced by lights of different color, using for the purpose the flicker photometer.

Dr. Steinmetz asked whether Dr. Lummer thought the flicker photometer correct for this use; that a ratio between two sources of light, expressed in ergs, does not express the ratio in light. He thought that the flicker photometer tends rather to give the former, due to the after effect of the longer light rays.

Dr. Lummer said that the question was one of exceeding difficulty; that it is not known yet just what the action is, and this is one of the points now being investigated in an endeavor to determine whether the same results are given by different observers.

Dr. F. Schniewind said that an interesting question had come to him. In gas manufacture, when the gas is enriched by benzol vapor, the light-producing power increases at first proportional to the enricher so long as the percentage is small; but, as this increases, the candle-power of the gas does not increase as rapidly. He wanted to know whether it is not possible that the temperature of the flame was lowered by the heat required to crack the larger amount of benzol vapor.

Dr. Lummer, in reply, could not say, but he thought that it was probable some such effect did take place, and the phenomena might be compared with those observed in the production of incandescent gas mantles. The brilliancy of the mantle depends upon the proportions of ceria and thoria contained, but the relation is not a simple one.

In closing the meeting a unanimous vote of thanks was given to Dr. Lummer for his courtesy in delivering the address, and this was conveyed to him by Dr. Sharp in a few appreciative words.

The meeting was then adjourned.

Lecture on Vesuvius and Pompeii Before the American Society of Mechanical Engineers.

On the evening of Thursday, March 21, John W. Lieb, Jr., presented a very interesting lecture on volcanology before the American Society of Mechanical Engineers, taking as his text the recent disturbances centering about Mount Vesuvius, in Italy. Supplementing the technical data, Mr. Lieb presented a series of very interesting views dealing both with the recent earthquake and with the historical features of Pompeii and the adjacent ruined territory. Following Mr. Lieb's address the society was favored with a moving-picture exhibit showing the volcano in eruption and scenes attendant upon the devastation. These pictures were presented and explained by the noted traveler and author, E. Burton Holmes.

Annual Report of the Directors of the American Telephone and Telegraph Company.

The annual report of the directors of the American Telephone and Telegraph Company for the year ending December 31, 1906, has been issued to the stockholders under date of March 26. The results of the business for the year 1906, as shown by the treasurer's statement appended, were as follows:

Gross Revenue	$24,526,097.82
Expenses, including interest and taxes	11,555,161.06
Net Revenue	12,970,936.76
Dividends paid	10,195,233.50
Carried to Reserve	1,773,736.62
Carried to Surplus	1,001,966.64

The net output of telephones during the year 1906 was 1,409,578, making the total number in the hands of the operating companies 7,107,836.

The number of exchange stations at the end of the year operated by the companies which constitute this system in the United States was 2,727,289, an increase of 485,922. In addition to this number, there were 297,220 exchange and toll stations operated by so-called sub-licensees, namely, independent companies or associations under sub-license or connection contracts and making use of the company's telephones. Adding also telephones employed for private-line purposes, the companies had a total of 3,068,833 stations, as against 2,528,715 stations at the close of the previous year.

The total mileage of wire in use for exchange and toll service was 7,468,905 miles, of which 1,688,987 were added during the year. These figures do not include the mileage of wire operated by sub-licensees.

Including the traffic over the long-distance lines, but excluding sub-licensees, the daily average of toll connections was about 462,000, and of exchange connections about 16,478,000, as against corresponding figures in 1905 of 368,000 and 13,543,000; the total daily average for 1906 reaching 16,940,000, or at the rate of about 5,455,000,000 per year, being sixty-four telephone calls for each man, woman and child in the United States.

The amount added to construction and real estate by all the companies, excluding sub-licensees, constituting the system in the United States during the year 1906, was:

For Exchanges	$59,971,094
For Toll Lines	13,585,659
For Land and Buildings	5,810,196
	$79,366,949

The amount added in 1900 was $31,619,100; in 1901, $31,005,400; in 1902, $37,336,500; in 1903, $35,368,700; in 1904, $33,436,700, and in 1905, $50,780,906; making the grand total of expenditure upon these properties during the seven years $298,914,255.

During the year 1906 the amount expended for maintenance and reconstruction, independent of construction, by all the Bell telephone companies in the United States was $32,814,568. This amount came from the earnings of the properties, and was charged into the expenses of the year. As a result of these expenditures for maintenance and reconstruction, the plant of the companies is in a better condition than ever before. That plant could not at the present time be reproduced for a less sum than $70,000,000 in excess of its cost. The scrap value of the lead and copper in the lines and cables alone is not less, at present prices, than $80,000,000.

The amount contributed by the American Telephone and Telegraph Company in 1906 by way of investment in its own long-distance plant ($5,642,000), in telephones ($1,737,000), in real estate ($330,000), and in the purchase of stock and bonds and in loans to its operating companies ($53,432,000), was in all $61,141,000, an addition of almost twenty-six per cent to its entire investment up to January 1, 1906.

In the expenditures for construction during the past year the Bell companies have proceeded more positively than ever before upon a definite theory which is believed to be that required to meet the conditions of the business as now known. They have built for the future as far as was consistent with sound economy. They have laid the foundations for the development that is sure to come and have not limited their construction to the business actually in sight.

The improvement in cables, made within the past few years, has revolutionized the art of telephone line construction. Not only is it now possible to place in underground ducts, cables containing four hundred or even six hundred circuits, but a pole line the carrying capacity of which would have been exhausted by forty pairs of open wires, can carry six hundred pairs of wires in the form of cables. Old-fashioned exchange pole lines rarely carried more than twenty pairs of open wires.

The great extent to which the telephone business was sure to develop became apparent about the year 1901, when the number of new subscribers increased nearly 220,000, as compared with about 167,000, the largest increase in any prior year. The increase was 257,336 in 1902,

247,184 in 1903, 274,466 in 1904 and 441,734 in 1905.

These large increases in the number of subscribers, which were attended by an equally large increase in the demand for toll service, practically exhausted the plant of the Bell companies and involved rebuilding that plant to a large extent. The systematic plant conditions that now exist. The effort has been made to design buildings and provide central office equipment that will not be exhausted in a short time. Careful engineering studies have been made of nearly all the large cities in the country, open wires have been displaced to a large extent, and underground

LEDGER BALANCES, AMERICAN TELEPHONE AND TELEGRAPH COMPANY, DECEMBER 31, 1906.

DEBTORS.

Construction, Equipment and Supplies	$40,336,776.14
Telephones	10,244,817.39
Real Estate	2,908,098.46
Stocks and Bonds	182,357,238.15
Patent Account	261,384.35
Machinery, Tools and Supplies	42,299.10
Cash and Deposits	3,018,024.43
Notes and Accounts Receivable	67,521,977.14
American Bell Telephone Co.	22,110,400.00
Old Colony Trust Co., Trustee	25,000,000.00

CREDITORS.

Capital Stock	$158,661,800.00
Surplus	8,027,454.52
Convertible Bonds	30,000,000.00
Collateral Trust Bonds	53,000,000.00
Collateral Trust Bonds (Collateral)	25,000,000.00
Five Per Cent Notes due May 1, 1907	20,000,000.00
Reserves	9,108,138.81
Notes and Accounts Payable	31,358,411.58
Contingent	18,645,210.25
$353,801,015.16	$353,801,015.16

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES.

EARNINGS.

	1905	1906
Dividends	$8,897,879.95	$10,281,437.60
Rental of Instruments	3,896,151.27	4,518,990.66
Telephone Traffic	6,529,556.82	7,522,082.31
Real Estate	82,384.46	67,296.29
Interest	2,306,858.79	2,136,290.96
	$21,712,831.29	$24,526,097.82

EXPENSES.

Expenses of Administration	$1,313,586.32	$1,629,802.85
Interest and Taxes	3,578,681.86	5,288,413.95
Telephone Traffic	3,786,524.72	4,636,944.26
	$8,678,792.90	$11,555,161.06
Net Revenue	$13,034,038.39	$12,970,936.76
Dividends Paid	9,866,355.00	10,195,233.50
Balance	$3,167,683.39	$2,775,703.26
Carried to Reserves	$1,743,295.16	$1,773,736.62
Carried to Surplus	1,424,388.23	1,001,966.64
	$3,167,683.39	$2,775,703.26

year 1906 has seen additions to construction which not only enabled the companies to take care of the 2,241,367 subscribers connected with the system on the first of January, 1906, and the nearly 500,000 added during the year 1906, but which resulted in plant conditions, based on scientific study, which will enable the growth of future years to be taken care of with an economy and efficiency due to the application of the most approved methods of work. Constant additions will have to be made to the plant, but they will largely be on predetermined lines, utilizing, extending and rounding out the construction and aerial and underground cables have been installed that were not merely adequate for the growth then in sight, but for a substantially larger growth. The lines upon which increases of plant should be made have been laid out in advance, so as to fit into the work now done.

As an indication of the extent to which the companies have built for the future, attention is called to the fact that at the present time not less than $25,000,000 is invested in circuits in cables that are not yet in use, but all of which will soon be in service, and that pole and conduit facilities are now installed which will take care of a very large number of cables over and above those that now exist.

There was during the year 1906 at least the usual amount of destruction of plant by sleet storms, washouts and fire. The San Francisco catastrophe undoubtedly inflicted upon the plant of the Pacific States Company, which operates on the Pacific Coast, a greater injury than any telephone plant ever suffered before. If it had not been for this disaster, the Pacific States Company would have gained not less than 30,000 subscribers more than it did in fact gain. The telephone plant in San Francisco has been rebuilt, and the service restored to a surprising extent.

As stated in the last annual report, convertible four per cent bonds of the company, to the amount of $100,000,000, were sold in February, 1906. By the terms of the contract, bonds to the amount of $30,000,000 were taken and paid for during that year. Construction work proceeded so rapidly throughout the country that, during the year, it became necessary for the company to obtain money on short-time notes to secure the funds required, in anticipation of the payments on the bonds. On the first of January, 1907, its short-time obligations amounted to about $21,000,000. It also became evident that if the great commercial development throughout the country which was taxing the resources of practically every public service company, and the telephone companies almost more than any other, was to continue, the proceeds from the bonds would not be sufficient to meet the necessary expenditures of the company to the end of the year 1907, as had been expected.

In January, 1907, therefore, the company sold three-year five per cent notes to the amount of $25,000,000. These notes were placed at a price that was reasonable in view of the abnormal financial conditions that have characterized the past year. From the proceeds of the securities sold the floating indebtedness of the company will be paid when due, and on May 1, 1907, the $20,000,000 three-year five per cent notes of the company, due that day, will be paid.

The gross revenue for the year 1906 of all the Bell companies in the United States, taken as a whole and excluding duplications, was over $114,000,000.

The gross revenue of the companies above given does not include the Bell Company of Canada, nor does it take into account the revenue of the Western Electric Company. The business of that company for the year 1906 was the largest in its history.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

An Electrolytic Rectifier.

A new type of aluminum electrolytic rectifier has been devised by O. de Faria, which is said to have some advantageous features. The rectifier is of the ordinary lead-aluminum type, the solution being sodium phosphate. The new feature is the arrangement adopted to prevent heating of the rectifier during the period of use. The aluminum electrode is in the form of a short cylinder suspended by an insulated conductor at the bottom and within a vertical lead cylinder which forms the other electrode. The latter is perforated at the bottom and at the top at the surface of the electrolyte, so as to allow the latter to circulate. During operation the heat developed at the aluminum plate raises the temperature of the surrounding electrolyte, and thus sets up circulation, which not only keeps the solution in actual use cool, but prevents polarization from taking place, and thus reduces the heating effect. The cells are grouped in the usual Graetz method, and supplied with rheostats for regulating the output and for forming the cells.—*Translated and abstracted from L'Électricien (Paris), March 2.*

The Positive Charge Carried by the α Particle.

Some time ago Frederick Soddy described some preliminary experiments which seemed to him to prove that the α particle is not, as initially expelled, charged. Although he has no reason to doubt the accuracy of these experiments, he does not now consider them sufficiently conclusive, as some recently published researches by Rutherford on the α particle have to be taken into account in their interpretation. These seem to show that the α particle carries two atomic charges. The reasoning on which the former opinion was based was that then held universally, that the charge of the α particle was the indivisible single atomic charge; and it was not necessary at that time to contemplate the possibility of any intermediate condition existing between the α particle, charged and uncharged. But it is clear that if, as Rutherford considers probable, the α particle carries a multiple charge, the results published previously are not sufficient, by themselves, to prove that the α particle, as initially expelled, is uncharged, for it might possess a fraction of its final charge initially, obtaining the remainder and becoming correspondingly more easily deviated magnetically in its passage through matter. The author has been unable to conduct further experiments in this matter, and as the question is a somewhat fundamental one, he feels that he should withdraw the original statement.—*Abstracted from Nature (London), March 7.*

Coal-Storage Under Water.

In 1902 the Western Electric Company decided to provide for the storage of a considerable amount of fuel. As experience with coal bunkers at one plant showed very clearly that the Illinois coals, which the company makes use of, when stored in ordinary bins exposed to the air, suffered materially from spontaneous combustion, it was decided to try storing a large quantity of coal under water. This was carried out with satisfactory results, as no trouble has ever been experienced there from spontaneous combustion.

When it was decided to provide for a large storage of coal at the new plant at Hawthorne, Ill., the same scheme was followed, and a storage pit, built of concrete, divided up into three sections and covering a ground area of about 310 by 114 feet, was decided upon. It is arranged for filling with water so as entirely to cover all the coal that may be placed in it. As constructed, each section is approximately fifteen feet in depth, and the whole pit has a capacity of about 10,000 tons, which reserve is kept exclusively for emergencies.

Coal cars may be emptied into or loaded from the storage pits while on any one of five tracks. A locomotive crane, fitted with a grab bucket, is provided for taking the coal out of the storage pit. No provision is made for drying the coal before use, as the handling of the coal will result in its being dry enough by the time it reaches the boilers.—*Abstracted from the Engineering and Mining Journal (New York), March 23.*

Reasons for Believing in an Ether.

Perhaps the most fundamental conception of modern physics which excites distrust from the outside is that of the ether which is assumed to fill all space. The non-physicist who has read of the oft-repeated, but entirely unsuccessful, attempts to detect the ether wind due to the earth's movement through space, and of the negative results of all direct experiments on the ether, begins to feel that the builders of physical theory are perhaps unreasonably tenacious of an idea which might best be dispensed with. Daniel F. Comstock here presents several of the reasons for believing in an ether which seem sufficient, because based directly on observation or experiment. The most important evidence is the simple fact that the velocity of light does not depend on the velocity of the source. This is shown by the normal apparent shape of the orbits of the binary stars, which would otherwise appear distorted. The meaning of this fact is that space possesses a positional property by means of which the magnitude of any motion can be defined, without reference to any body in the universe, and this motion is what the physicists call motion with respect to the ether. For example, an observer imprisoned in a windowless box thrown at random into space could, by measuring the velocity of the light transmitted in different directions throughout his enclosure, accurately define his speed through space. There is an entirely different experimental truth which leads to the same conclusion. It is generally accepted that two similarly charged bodies, when moved side by side, have superimposed upon their mutual repulsion an attraction which depends upon the fact that, when moving, they act like two parallel electric conductors. This deduction follows from Rowland's classical experiment. If the two charges, stationary with respect to each other, are considered alone in space, it is evident that they would furnish to the imprisoned experimenter another means of finding his motion relative to space, for the strength of the above-mentioned attraction depends only on this absolute motion. We are conscious of matter only as a collection of properties, and one of these properties certainly is that it is capable of marking position; therefore the unknown reality which exhibits this positional attribute in space as one of its properties can be said to resemble matter to this extent at least, and upon this sure foundation can fitly be based the physicists' conception of an ether.—*Abstracted from Science (New York), March 15.*

New System of Audible Distant Signaling on the Great Western Railway, England.

A simple and ingenious signaling system is being tried by the Great Western Railway Company, England, to supplement the usual semaphores during foggy weather. The signals thus produced are audible and consist of two distinct sounds, one a whistle brought into action as a caution signal, and the other an electric bell, showing that the line is clear. Both of these signals, when started, continue to sound until the engineer stops them. The locomotive carries a contact shoe placed two and one-half inches above the running rail. At each signal a ramp is placed between the running rails, the top being four inches above the head of the latter. This ramp is connected by a wire to a switch in the signal tower, by means of which it can be connected to a battery. The locomotive is supplied with a small whistle, an electric bell, a battery, two electromagnets and the contact shoe. The electromagnets act upon a common armature to hold closed the valve of the whistle. When running normally, current from the locomotive battery is supplied to one of these magnets, but, in passing a signal, the contact shoe is lifted and the locomotive circuit opened, thus causing the magnet to release the armature. The whistle will then sound, indicating caution. If, however, the line is clear, the contact shoe picks up current from the ramp and thus excites the second electromagnet, which holds the whistle valve closed when the first lets go. The current at the same time throws a relay, which rings the bell on the locomotive. The ramp consists of an angle iron with the web up, bent down at the two ends and supported on a wood stringer. It is about forty feet in length for normal positions. Sixty feet has been found sufficiently long for the highest speeds. Where the road is single track, independent signals for trains traveling in the two directions are made by changing the polarity of the contact rail.—*Abstracted from Electrical Engineering (London), March 7.*

The Iron Losses in Asynchronous Machines.

A discussion is given here of a method of separating the various iron losses occurring in induction motors. These losses occur both in the stator and the rotor. The losses in the stator are for a given frequency and applied pressure nearly constant for all loads, although while the losses in the rotor depend on the slip, under normal working conditions the slip is small, so that the rotor iron losses will generally be small. In addition there are subsidiary losses which arise in the following way: When a tooth of the stator is opposite a tooth of the rotor, the flux in both teeth will be a maximum. When the tooth of the stator comes opposite a slot in the rotor, the flux in the tooth will diminish, and thus pulsations of high frequency are set up in all the teeth, which give rise to corresponding losses. It was to determine the magnitude of these losses that this investigation was undertaken. It consists first in separating the losses of a seven-horse-power induction motor by means of the Bragstad running-down method, which consists in bringing the motor up above synchronism and then cutting off the power and letting it die out. The rotor circuits are then opened and the stator is excited, and the same process continued. The machine is then driven, by means of a motor, at different speeds, the power supplied to it electrically at each measured. In this way it becomes possible to separate the friction loss, and the hysteresis and eddy current losses in the stator. To investigate the pulsations in the teeth it is necessary first to determine its magnitude. This pulsation is superposed on the variation due to the rotation of the main field, and it becomes necessary to separate the two effects. To accomplish this a coil of many turns of fine wire was wound around one tooth of the rotor and its ends brought out and fastened to two slip rings. The same coil was then wound around one tooth of the stator, and its ends brought out to two terminals. The normal pressure was then applied to the stator exciting winding, and the rotor coupled to a motor and run at various speeds. The electromotive force induced in the rotor search coil consists of two components, one due to the rotation of the main field, and the other to the pulsations in the teeth. The former component will have a magnitude that will be proportional to the difference of the speed of the main rotating field and of the rotor. The latter component should be directly proportional to the speed of the rotor. At the high frequency of the pulsations there will be damping, and the simple proportion will then not hold. As the speed of the rotor increases the former component will diminish, and the latter increase, until synchronism is reached. At synchronism the main rotating field is at rest relatively to the rotor, and therefore the only electromotive force induced in the search coil is that due to the pulsations precisely at synchronous speed. These pulsations depend on the density of the main field at the instant in that tooth, and vary from zero to a maximum and back to zero as the main field moves through a distance equal to a pole pitch. What is required is the electromotive force induced in the coil for all points in the field, because it is not practicable to run the rotor steadily at synchronous speed. To obtain this it is necessary to measure the electromotive force induced in the search coils for speeds above and below synchronism and draw a curve. The point where this curve cuts the ordinate corresponding to synchronous speed gives the electromotive force required. This may be done by passing through the rotor winding currents such that they will induce in the stator the same flux as that produced normally. The rotor is then revolved in a direction opposite to that produced by the rotating field at various speeds, and from this the mean electromotive force induced at synchronism may be determined. To determine the pulsations of the flux in the teeth at different speeds it is necessary to alter the frequency and speed of the current, keeping the flux density constant, and changing the electromotive force in the same ratio. Experiments were carried out in this way on two motors, one having half-closed slots on both stator and rotor, and the other open slots on the rotor. Complete data for the latter test are given, and the method of deducing from the curves the values required is shown. The results of the test are given in tabular form, and show that for the motor under consideration, which was rated at seven horsepower, the eddy current losses in the teeth varied in the following way: At a frequency of fifty cycles and an applied pressure of 100 volts, the rotor tooth loss was fifty-three watts; the stator, nine watts. At the same frequency and 130 volts, the rotor loss in the teeth was eighty-three watts, and the stator 13.8 watts. At a frequency of forty and a pressure of 104, the rotor loss was fifty-five and the stator 9.7 watts. At a frequency of thirty and a voltage of fifty-nine, the rotor loss was 24.5, and the stator loss 2.8. These figures make no allowance for the hysteresis loss due to the pulsations, which are, at the most, small, and may be neglected.—*Abstracted from the Electrician (London), March 1 and 8.*

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

EDITED BY CHARLES A. PARKER.

Securing the Cooperation of Architects, Doctors, Etc.

There has been of late an increased sentiment in favor of securing the cooperation of architects, builders, doctors, dealers, etc., in furthering the sale of electric current. The arguments in favor of an endeavor to secure this cooperation are many—as are the means of securing it.

Would not a manager, charged as he is with the responsibility of developing the earning capacity of the property entrusted to him, be guilty of gross negligence if he did not avail himself of every means at his command to secure the desired development? He most certainly would. And he, knowing that dividends depend upon increased sales, and that the value of the plant goes hand in hand with the earning capacity, his self-interest demands that he undertake the introduction of appliances which will use current.

How is this to be accomplished?

The ways are many and the means of reaching the end through these numerous ways are equally as many. The plan of enlisting the services and cooperation of the architects, builders, doctors, druggists, etc., is the only one we will deal with here.

You could first gain their friendship by presenting them with an electric cigar lighter, chafing dish, heating pad, flat iron, or small domestic motor. This will not only procure their good will, but will enthuse them with the various conveniences and uses of electrical devices, and when the wide range of influence such men carry is considered, you can readily see that your little gift can not fail to compensate you a hundredfold.

The architect and builder will be much more likely to specify electric lighting for every building he possibly can, once he has become, himself, an enthusiast, and will enthuse his client with the many uses to which electric current can be put.

You thus may have these influential men constantly preaching the gospel of electricity and sowing the seeds in soil where they will bring forth the fruits of increased business. Besides, the architects and builders themselves will become liberal users of the juice from which you derive your revenue.

The same benefit can be had by befriending the doctor and making him acquainted with the electric heating pad, food warmer, etc. He is generally looked upon by his patients as an infallible authority, and suggestions from him are eagerly sought after and usually carried out—for his advice costs money.

Think of the opportunities he has for prescribing an electric heating pad for neuralgia, rheumatism and many of the other ills to which the human body is subject. Think of the weight it would carry to have him casually mention the unhealthfulness of the open-flamed light and the improvement in the wholesome atmosphere of a house, which is made possible by lighting with electricity.

Every solicitor and manager has his doctor friends whom he can enthuse with the superiority of electric light over other means of artificial illumination as a healthful light for the home, office or store. And these same physicians can be so influenced as to become a strong right arm of your new-business department, working without money and without price.

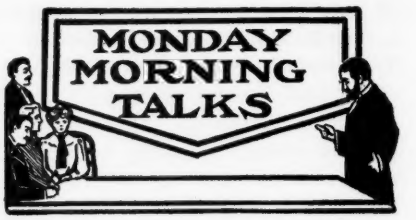
You could even go as far as to have a well-known doctor foster a strongly written and convincing article in your daily paper. It's good advertising—it paves the way, making it possible to sell current along the lines of least resistance.

When you think of these things you are thinking of the increased sale of your current. And you know what this added business means to your company—it's like velvet.

In the light of the experiences of others, we are inclined to believe the plan of procuring the cooperation and friendly support of influential men is a coming plan, and, as one architect expressed it, "It is a mighty good thing for the central station."

You can take up this whole study of the business problem as you would take up the study of a machine. Like an engineer would do it. Your object is to increase the useful work of your machine and to increase its efficiency.

Overcome the resistance and certain defects, and you have a machine capable of more efficient and useful results. Let each morning's waking thought be—as the Cooperative Electrical Development Association's motto hath it—"All together, all the time, for everything electrical."



Under this general heading we shall present to our readers a series of bright, stimulating talks to solicitors, which, we believe, will prove valuable to managers of new-business departments in suggesting points which they can profitably bring out in their occasional meetings with the company's representatives.

We shall gratefully accept contributions and suggestions from any of our readers.

How much do you read, anyway, boys?

Somebody once said, "It's an American fault to skim over things—especially printed things."

And, by George! I think he's right.

We read a book in a day—a paper in ten minutes—an advertisement at a glance.

How much we lose!

Of course, I realize it is impossible to read everything.

But don't you agree with me that a few good books, magazines and trade papers, well read and digested—mind you, I said digested—are worth more than a thousand superficially glanced over?

Now, I feel pretty safe in making the assertion that you fellows, as a whole, do not read enough about your own line of business.

Some of you have an idea that trade journals are to-day too technical to be interesting.

Well, they may be at times, but all the same, a salesman, as well as a buyer, can not know too much about the commodity he sells.

Besides, there's a lot of very interesting "New Business" matter being published these days in the more up-to-date and progressive technical journals.

Suppose some customer should come at you to-morrow with "What is electricity—how is it made—what's an ampere?" Or some such question.

Could you explain to him in a clear and intelligent manner?

I tell you, boys, it's only by keeping the door of your mind constantly open,

by imbibing knowledge relative to your business, that you can attain the highest state of efficiency in salesmanship.

You'll acquire a stimulus reading the various trade papers and journals, which will at once make you of more value to the company, and yourself.

Remember, it isn't length of experience in a business that counts. It's knowledge.

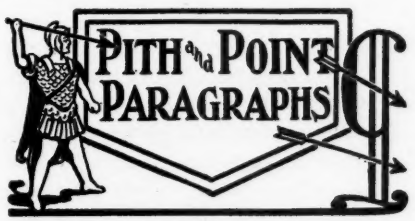
I could name you scores of cases where men with but a short experience know more about the business than some of their associates who have spent three times the number of years in the work.

Why?

Simply because these knowing ones kept the doors of their minds open. They read and studied about the business, and digested what they read.

So get in the game, boys! Read up every chance you get—keep your mind open to impressions—and you'll soon enjoy the distinction of being a well-read man in your line.

And take it from me, that's worth a whole lot to you.



Under this heading we shall, from week to week, present to our readers a little series of inspirational aphorisms (original, aboriginal and selected), which will, we believe, prove stimulating and suggestive to those who are interested directly or indirectly in the sale of central station current.

The cross-eyed person shows that there is more than one way of looking at things.

An ounce of performance is worth a pound of preachment.

It is sometimes good policy to leave a few things unsaid.

Solicitors should work without whims, jealousy, envy or fear.

The discouraged solicitor is unwise when he tries to pull himself out of trouble by means of a corkscrew.

Making false statements is like calling a bigger man names; it is liable to give a man a black eye.

People will pay more for electricity if you tell them why it's worth it.

There is a good market for every good thing—but you must hustle to find it.

Perfection is a good thing to strive for, but a calamity to arrive at.

No solicitor or manager who has achieved great results can tell just how he did it. Men are a mystery, even to themselves.

When you tell a man all your troubles you become one of his.

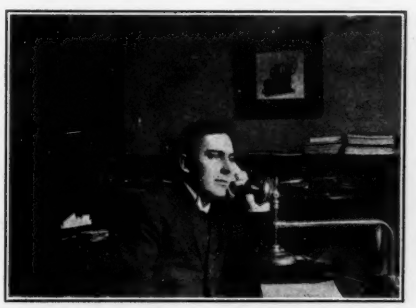
A solicitor who is looking for contracts along the cocktail route is like the sinner who is looking forward to good skating in the hereafter.

It will be our endeavor, from week to week, to present in this department brief notices of activities among the central stations, as gathered from men who are in the field and, consequently, in close touch with the progress of the new-business idea and its acceptance by central station managers. Contributions to this department are solicited, and will be received with much appreciation by the editor.

If you are doing something a little better than or different from the other fellows, and think it would make interesting reading to ELECTRICAL REVIEW readers, send in your schemes and plans. They will be gladly received.

Address all communications to Charles A. Parker, care of the ELECTRICAL REVIEW.

The Maryland Telephone Company, of Baltimore, Md., believe in keeping everlastingly after new business, with the combination of the very best direct-by-mail advertising service, energetic solicitors, newspapers and theatre programme advertising.



Mr. H. M. Cosh, contract agent of the Maryland Telephone Company. A good percentage of his company's success is due to his efforts.

This company uses a sixteen-page monthly bulletin six inches by nine inches, printed in two colors, handsomely illustrated and written in an interesting, convincing manner, telling of all the advantages of electricity for light, power and domestic uses—it covers the whole field.

Besides the bulletin, this progressive company sends out a special direct-by-mail store service, a power service and a residence service.

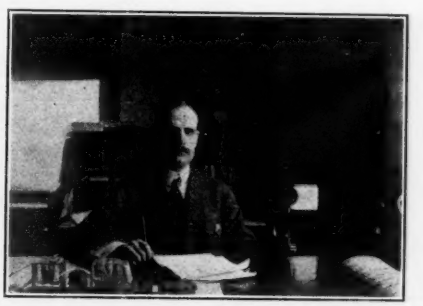
These special pieces of advertising consist of mailing cards, folders, booklets and follow-up letters. The letters are printed so as to imitate the typewriter, having the appearance of personal letters,

Mr. B. S. Josselyn, vice-president of the Maryland Telephone Company, who is a liberal and firm believer in advertising and new-business methods.

as the names and addresses are filled in with the same color ribbon. The headings on these letters are well designed, and are suggestive of electricity for the home, the store or for power, depending on the parties to whom they are sent.

In all these pieces of advertising there is enclosed a return postal for interested parties to fill out, if they wish to make an appointment with a representative of the company to learn more concerning electricity for certain purposes.

H. M. Cosh, contract agent, says that their new-business department is a "winner," and the results more than justify the expense which they have appropriated for advertising, solicitors, etc.



Mr. William P. Byers, another energetic officer of the Maryland Telephone Company.

Just as an illustration, Mr. Cosh says at the time of the big Baltimore fire there were 3,300 users of electricity in Baltimore. To-day the Maryland Telephone Company alone is supplying 3,100 consumers satisfactorily with light and power. Most of these are using electricity for the first time.

During the year ending December 31, 1906, this company introduced the com-

forts of electricity in 350 homes in Baltimore, and it is the war cry of the Maryland new-business force that no one using electricity would return to any other form of illumination.

Handsome bulletin of the Maryland Telephone Company. The company has found this kind of advertising to be one of its best business-getters.

This company also states that they have the proud distinction of furnishing current for all the theatres in Baltimore. This, we believe, is quite an advertisement in itself, and we note that the company does not hesitate to harp on this point in their advertising.

This company has a large force of solicitors constantly in the field, and each solicitor is expected while at work to telephone the contract department every hour, so as to be in close touch with whatever business may come up relative to his respective territory.

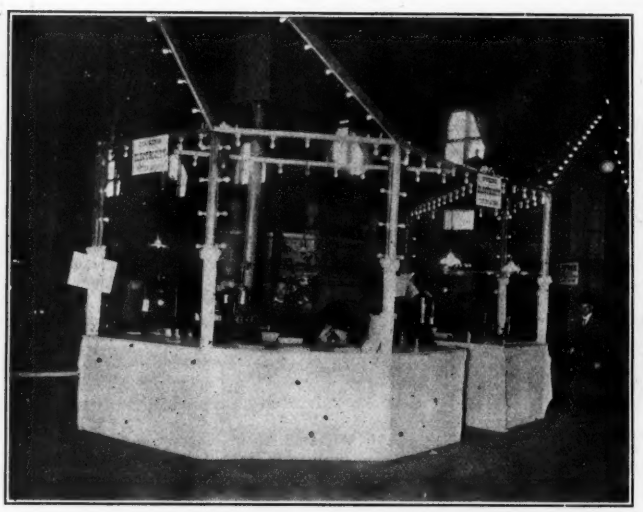
At the Pure Food Show held in Baltimore, November 12 to December 1, 1906, the company had several booths. One booth was used for portable fixtures, another booth showing the evolution of incandescent lamps, and then there was the cooking booth, which had the electric kitchen, and demonstration.

Also at the Pure Food Show the company freely distributed its elaborate bulletin with a card stating that the company issued this publication monthly and would be glad to add any name to their mailing list. The company states that there was special interest shown at the different booths, and it is confident it did its full share at the show to popularize electricity, as well as doing good advertising, as it is its desire to impress every one who resides in Baltimore with the slogan, "You can't go wrong if you take the right light."

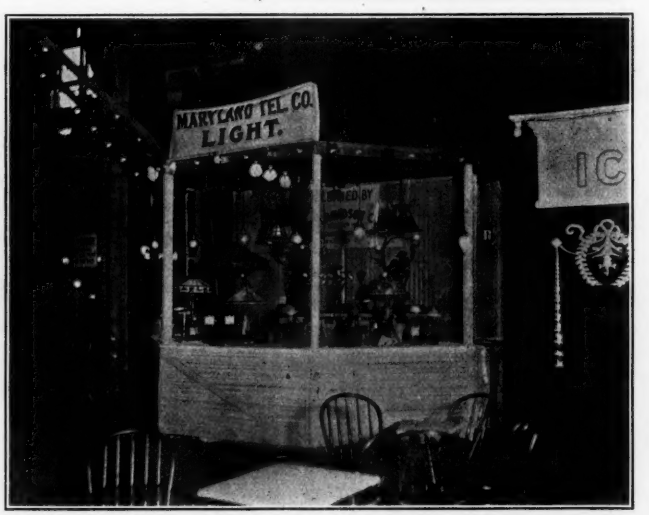
One of the attractive mailing cards sent out by the Maryland Telephone Company.

Electric Driving in Textile Mills.

Although the advantages of the electric drive in textile mills have been frequently set forth, the great weaving industry, in England, has been backward in this development, and even to-day this system is looked upon there rather as one for remodeling old mills than for introduction into new. The great objection to the electric drive is the first cost, but it has been pointed out that the increased output of the mills, even if it amount to only two per cent, is sufficient to wipe out entirely the coal bill. Practical experience has not yet proved any great difference in first cost between the individual and the group systems of driving, everything considered. Although the larger motor for the group system has a higher efficiency than the smaller for individual driving, the former method calls for belts and shafting. To settle this point definitely, one of the larger Eng-



Showing another booth of the Maryland Telephone Company at the Pure Food Show. This company believes in showing the people what nice things are possible in homes wired for electric light, and its efforts are being crowned with success.



Booth of the Maryland Telephone Company, of Baltimore, at the Pure Food Show. The managers of this company are "men of the people," and in the energetic and persistent use of advertising, soliciting and practical demonstrations to popularize electricity, are worthy rivals of our Denver friends.

lish mills has installed the group system in one shed, where there are twenty-five frames driven by a single motor; and in the next shed there are twenty-five similar frames, each driven by an individual motor. For driving mules the group system is almost necessary, because of the great variation in power. Records recently taken show that with four pairs of mules running with an average load of 100 horse-power, the driving power varied by twenty-six horse-power; and with ten pairs and an average of 240 horse-power, the variation amounted to ninety horse-power. An excellent example of the electric drive is that in the Heasandford Manufacturing Company's weaving shed near Burnley. There is here a private generating plant consisting of a three-phase alternator rated at 550 kilovolt-amperes, at forty volts, fifty cycles, and a similar set rated at 200 kilowatts. Power is supplied from these to the motors, which are of the three-phase, squirrel-cage, induction type. The motors are carried on brackets fixed to the wall, and there are twenty-three, each driving a line of shafting. Twenty-one of these lines drive a double row of looms, the motors being rated at twenty-five horse-power. The two end shafts drive a single row of looms, each being driven by a fourteen-horse-power motor. There are in this room 1,600 looms. The motors run at a considerably higher speed than the shaft, the reduction being made by means of rawhide pinions gearing with cast-steel gears. The starting switch for each motor is placed immediately below it upon the wall. Six hundred brake-horse-power in motors has been installed in this mill. —*Abstracted from the Electrical Review (London), March* 8.

From Our Contemporaries.

Among other words of appreciation concerning the Quarter-Century Number of the ELECTRICAL REVIEW, March 9, the following expressions are of interest, coming as they do from such widely differing sources, differing both geographically and technically:

"The ELECTRICAL REVIEW of New York city, of which Mr. Charles W. Price is president and editor, has just celebrated its first twenty-five years of existence by issuing a 'quarter-century number' which is worth reading through, including the advertising pages, of which we are glad to note there are a goodly number. The issue contains among other good material a number of reviews on what has been wrought in a quarter century's progress in the applications of electricity, including the lighting, power, traction and telephone fields. There are given several portraits of men who have helped to make this progress. *Electric Traction Weekly*, the youngest paper in the field, herewith extends its felicitations to ELECTRICAL REVIEW, the oldest paper devoted to electrical interests, and wishes it many happy returns of the day."—*Electric Traction Weekly*, Cleveland, March 16.

"The quarter-century number of the New York ELECTRICAL REVIEW, dated March 9, was devoted not to blowing the paper's own horn, but to interesting articles on electrical progress in the last twenty-five years. The edition was freely illustrated with portraits and with views of important electrical installations.

"Although the ELECTRICAL REVIEW is published by and for specialists, there is much in its contents which appeals to the imagination of a layman, and impresses him with the wonderful scope of electrical science."—*Fourth Estate*, New York, March 23.

The Ohio Electric Light Association.

The thirteenth annual convention of the Ohio Electric Light Association will be held in the New Boody Hotel, Toledo, Ohio, August 20, 21 and 22. The programme, as far as completed at the present time, will consist of papers upon high-efficiency lighting units, uniform records, cost determinations, electric heating devices, relationship of the Cooperative Electrical Development Association to the central stations, luminous arcs from the standpoint of central station operation, the proper type of prime mover for stations of 500 kilowatts capacity or less, factory lighting, helps to a solicitor and what fifty cents' worth of electricity will do, and best ways of meeting natural gas and gasolene competition.

The following committees have been appointed:

General Arrangements—E. J. Bechtel, Toledo, chairman; W. G. Nagel, F. Bissell and J. E. Lockwood, Toledo.

Entertainment—W. J. Hanley, Columbus, chairman; F. W. Willcox, Harrison, N. J.; Clifford P. Billings, Cleveland; A. C. Robeson, Greenville, and H. C. Boyer, Toledo.

Reception—B. S. Young, Ada, chairman; A. A. Serva, Fort Wayne, Ind.; L. B. Hoit, Cleveland; N. C. Cotabish, Cleveland; J. H. Maxon, Gallipolis; Elliott Reynolds, Pittsburg; E. N. Riddle, L. C. Norton, T. D. Buckwell, Frank Maunsell and H. E. Adams, Toledo.

BOOK REVIEWS.

"Questions and Answers from the Gas Engine." Cincinnati. The Gas Engine Publishing Company. Cloth. 278 pages. 5 by 7¼ inches. Supplied by the ELECTRICAL REVIEW at $1.50.

A compilation has been made here of the answers to inquiries which have been made and published in the columns of *The Gas Engine*. These queries relate to all phases of gas-engine design, construction and operation, and the replies contain a vast amount of general information on this type of prime mover.

"Steam Turbines, Practice and Theory." Lester G. French, Brattleboro, Vt. The Technical Press. Cloth. 418 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $3.

The volume contains twenty chapters, the first dealing with steam turbine principles. The second takes up at length early steam turbine patents. The next succeeding six chapters discuss the various types of steam turbines, the greater part of the matter dealing with European design and manufacture. Chapters IX and X compare the steam turbine with reciprocating engines. The following three chapters take up, successively, the flow of steam, properties of steam and calculations upon the flow of steam. It should be noted that in the chapter dealing with the properties of steam the author has given credit sparingly, and, unfortunately, where credit is given, frequently it is incorrect. The following chapters contain, among other subjects, information on the commercial aspect of the turbine, operation of the De Laval, Parsons and Curtis turbines, and condensing apparatus for securing high vacua. These three chapters were evidently written for the power-plant designer, but for this purpose they are somewhat unsatisfactory. The book closes with a statement of the status of marine turbines, and has an appendix containing curves showing the kinetic energy of a steam jet in foot-pounds, the velocity of a steam jet, and tables of the properties of saturated steam. While the volume contains a good many illustrations, most of them are well known to the reader of technical journals. Undoubtedly, the book is a useful one to the turbine designer who desires to familiarize himself with the details of other designs. The general arrangements of the chapters, however, could be improved, and it might be expected that this arrangement would be good, as the author was for nine years editor of a technical journal. Taking the latter fact into consideration, it would naturally be presumed that he would know how to place credit where credit is due, a point which, as already mentioned, has been neglected.

INDUSTRIAL SECTION

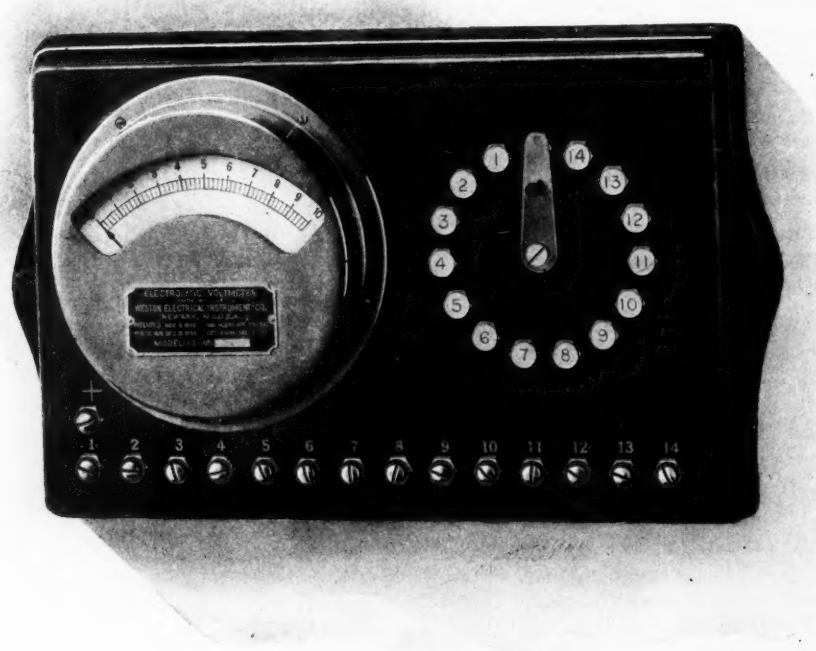
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

A New Electroplaters' Voltmeter.

The accompanying illustration shows the model 131 electroplaters' voltmeter placed on the market by the Weston Electrical Instrument Company, Waverly Park, Newark, N. J. In plating establishments the voltmeter is an important piece of apparatus, as upon its reliability the quality of the work depends. The amount of current consumed in a bath is governed by the quantity of work being done, and the current flowing is, of course, dependent upon the voltage. Too much current results in burned work, while too little current results in a thin deposit which comes off under the buffing wheel, necessitating replating.

Owing to the apparently high first cost of furnishing each tank with a reliable and accurate voltmeter, platers have hesitated to properly equip their plants, using unreliable instruments or doing without instruments of any kind. Realizing the importance of first cost from the plater's standpoint, the Weston Electrical Instrument Company has designed this voltmeter, which is especially adapted to this work, obviating the necessity of having an instrument for each tank, and enabling the plater to avail himself of an extremely accurate and reliable instrument at a low cost.

The instrument consists of an accurately calibrated Weston voltmeter contained in an air-tight, waterproof case, which adequately protects the internal mechanism from the action of fumes usually present in a plating room, and mounted on a small wooden switchboard containing fifteen binding posts and a fourteen-point switch. One of the binding posts, marked "plus," is attached to the positive side of the plating generator or line, while the remaining posts are to be attached one each to the cathode side of each tank. After the connections are made the voltmeter is thrown in circuit with any desired tank by turning the switch handle to the numbered point corresponding to the tank it is desired to test. The instrument is designed to accommodate fourteen tanks, which is considered the maximum number that can be conveniently operated from one point.



A New Electroplaters' Voltmeter.

A New Couple Type Storage Battery.

The Gould Storage Battery Company, New York city, has placed on the market a new form of tandem couple type storage battery, an illustration of which is shown herewith. This type of storage battery has been designed especially for operating fire-alarm and police-signal telegraphs, private branch telephone exchanges and railroad signal systems. A feature of this new design of cell is the placing of the plates edge to edge, instead of face to face. As all parts of both sides of both plates are exposed to the same conditions of acid supply and exposure to the electrolyte, charge and discharge proceeds at the same rate in every part of the grid. The grid is spun out of hard-rolled lead, and because of this special construction the plate will retain its original capacity and shape for a long period, no part giving way until the whole plate gives out.

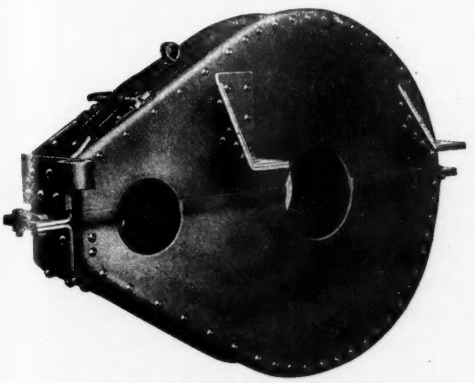
The positive and negative plates of the neighboring cells are joined by thick, substantial curved lead bonds burned to the plates. No bolts are used, except at the end of each row of cells. This permanent connection saves time and trouble in assembling the battery, enables the plates to be quickly lifted out for inspection as well as for cleaning, and avoids corrosion of bolted connections by the acid fumes, also keeping as low as possible the resistance of the connections.

A New Couple Type Storage Battery.

It is announced that the fire department of one of the largest cities in the country has recently installed several batteries of these tandem couples, and reports unusually satisfactory results.

The "Lyon" Sheet-Steel Gear Cases.

The accompanying illustrations give a good idea of the sheet-steel gear cases supplied by the Electric Service Supplies Company, Philadelphia, Pa. The feature of greatest interest in connection with these gear cases is their durability. The "Lyon" case, if struck accidentally, does not break, but bends, and can be hammered into usable shape with little effort. The "Lyon" cases weigh from seventy-five pounds to 100 pounds less than cast cases, and if the case should meet with an accident which would throw it to the street, the case would not derail the car, as the



LYON'S SHEET-STEEL GEAR CASE.

wheels would pass over it, leaving the case as the only loss. Because of their lighter weight they are also easier to handle in the car pit.

These cases are doubly strengthened where the greatest strains come. They are reinforced at both ends by heavy steel plates, both inside and outside. All brackets are triply reinforced. One of the illustrations shows the top section inverted.

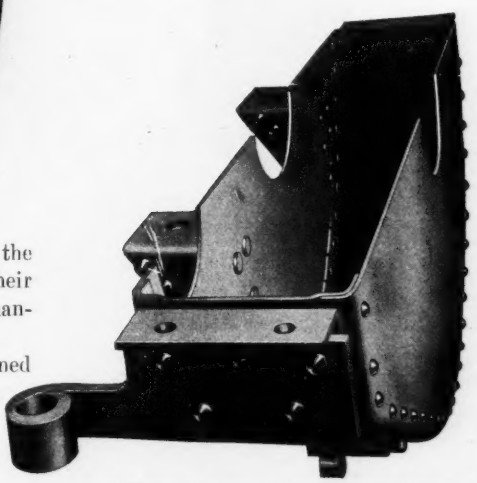
The rivets, which are of the best Swedish iron, are liberally used, and cold-riveted under thirty-five pounds' pressure. This expands the rivet until the opening is completely filled, leaving no chance for vibration or shaking loose.

Allis-Chalmers Steam Turbo-Alternators Recently Put in Service.

The successful starting of a high-power steam-driven unit, whether reciprocating or rotary, is always an operation accompanied by more or less liability to accident, due to any one of the manifold elements in design, construction or erection which may influence the final results. The steam turbine, occupying as it does a comparatively new place in the power field, is judged closely by the results obtained, and particularly is its initial performance watched and passed upon accordingly.

As one of the direct results of its many years' experience in designing, building and erecting reciprocating engines of all kinds, the Allis-Chalmers Company has been particularly fortunate in successfully placing its steam turbines and generators in service in various parts of the country. Practically without exception these units have been erected, put into operation and accepted in record-breaking time, without accident or mishap of any kind.

One of the first of the large Allis-Chalmers turbo-alternators to be installed was the 5,500-kilowatt unit at the Kent avenue station of the Brooklyn Rapid Transit Company, Brooklyn, N. Y. Steam was turned on, March 22, to dry out the generator. On March 27, owing to a breakdown in one of the other plants of the Rapid Transit Company, a sudden call was made for power. The new unit was



TOP HALF OF LYON'S SHEET-STEEL GEAR CASE.

hastily put in operation, and, within twenty minutes after the preparation had been completed, it was delivering 4,000 kilowatts. Since then this turbine has been operating continuously, generating on an average 6,000 kilowatts and up to a maximum of 8,300 kilowatts, taking heavy loads on the morning and evening peaks.

At the Brooklyn Edison Company's Gold street station, Brooklyn, N. Y., the erection of a 5,500-kilowatt Allis-Chalmers turbo-alternator was begun in April and completed in very short order, the machine being operated for the first time on June 16. From then on, this unit has satisfactorily carried all the load to which it has been subjected.

A 1,500-kilowatt Allis-Chalmers turbo-generator unit at the power-house of the Memphis Consolidated Gas and Electric Company, Memphis, Tenn., was shipped on September 8, and ready for steam and condenser pipe connections on September 16. On November 15 the steam connections were blown out and the machine placed in operation. After running for fifteen days the turbine was accepted. The temperature rise of the generator has always been far below the contract guarantee, and both it and the turbine are capable of carrying much heavier overloads than those specified in the contract.

A 500-kilowatt Allis-Chalmers unit for installation in the power-house of the Western United Gas and Electric Company, of Aurora, Ill., was delivered complete on October 8. It was ready to turn over on October 11 and the generator was dried out by the 14th. The new unit was put on the circuit on October 17 and was immediately called upon to carry an overload, which it did satisfactorily. Since that time this turbine and alternator have undergone rigid acceptance tests both at overload and three-quarters load, with the result of having bettered the guaranteed steam consumption by eight and one-quarter per cent for the overload and 9.6 per cent for the three-quarters load test. The unit has been in continual operation since, carrying all loads placed upon it.

The power station of Jacksonville, Fla., has a 500-kilowatt Allis-Chalmers turbo-generator unit fully erected and operating and a second unit of the same capacity on the way to Jacksonville. The first unit, as the result of an accident to the other apparatus in the power-house, was suddenly called upon to pull 500 kilowatts for seven hours straight and a maximum load as high as 700 kilowatts, with entirely satisfactory results.

A number of Allis-Chalmers turbo-generator units shipped within the past month or two have recently been started or are now awaiting steam connection. A 1,000-kilowatt unit at the power-house of the Kokomo, Marion & Western Traction Company, at Kokomo, Ind., has just been erected, and the turbine was started up for the first time on the 17th inst.

Out of three 1,500-kilowatt units for the Milwaukee Electric Railway and Light Company, one now being erected will probably be started up in the course of the next two or three weeks. The second turbine has been received on the ground, but its erection not yet begun.

Erection of Allis-Chalmers turbo-alternators is now in progress in the plant of the Meriden Electric and Light Company, Meriden, Ct., where a 500-kilowatt unit is being installed; at the power-house of the Canton Light, Heat and Power Com-

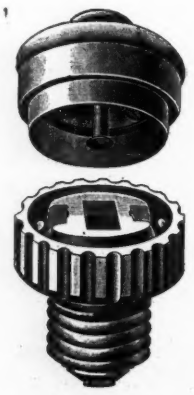
pany, Canton, Ohio, where another 500-kilowatt unit is going in, and at the works of the National Cash Register Company, Dayton, Ohio, where a 1,000-kilowatt unit is being installed.

Three 1,000-kilowatt units for the Western Canada Coal and Cement Company are on their way at the present time to the plant of the company, located near Calgary. Units ranging in capacity from 500 kilowatts to 6,000 kilowatts are in the West Allis shops nearing completion for the Jamestown Woolen Mills, Jamestown, N. Y.; Savannah Lumber Company, Savannah, Ga.; Flatbush Gas Company, Brooklyn, N. Y.; Indianapolis, New Castle & Toledo Railway, New Castle, Ind.; Helderberg Cement Company, Howes Cave, N. Y., and Kings County Electric Light Company, Gold street station, Brooklyn, N. Y.

A Separable Swiveling Attachment Plug.

The Sarco Company, 906 Sixth avenue, New York city, has recently placed upon the market an attachment plug which is not alone separable, but is also a swivel plug and separable at any angle.

This appliance has a circular brass band inserted in the top cap, which is connected and swivels with the bottom



SHOWING PLUG SEPARATED.

portion of the plug, engaging with two phosphor-bronze circuit-makers, making one pole, while the centre pole is an extended stud which engages in a ball-bearing lock, so that the plug may be separated at any angle. The plug can be inserted completely made up into a socket, and the twisted cord readily untwisted by the swiveling action of the plug. Should the cord be pulled sidewise the plug will separate at the angle, eliminating any possibility of the contacts becoming disarranged.

The "Helios" Flaming Arc Lamp.

The accompanying illustrations show a new type of flaming arc lamp placed on the market by the Helios Manufacturing Company, Bridesburg, Philadelphia, Pa. The main structure of the lamp consists of a heavy brass tube connecting the

"HELIOS" ENCLOSED FLAMING ARC LAMP.

lower brass plate with the top casting, and to which is secured a casting which supports the resistance spools and the carbon-holder guides. Inside of the main tube is a rod operated by a magnet in the top of the lamp, which is energized when current is thrown on, drawing the rod upward; and thus, by means of a presser foot at the lower end of the rod, separating the carbons and striking the arc.

The blowing magnets, as well as the plunger magnet, are wound with asbestos-insulated wire. The flexible cables leading to the carbon-holders are insulated with glass beads. The resistance spools are wound on grooved porcelain forms.

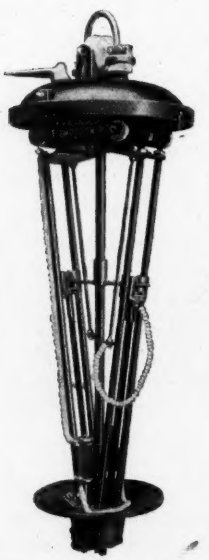
There are no clutches, chains, gears nor shunt windings in this lamp. The carbons feed entirely by gravity, and the bridge connecting the carbon-holders insures equal feeding of the two carbons. The binding posts are substantial. The cases are made of either brass or bronze, in any desired finish, for either indoor or outdoor use. The special-shaped globe is so designed that the light rays will pass through it nearly at right angles—that is, the shape of the globe is designed to follow practically the shape of the arc itself.

These lamps require forty volts at the arc, and may be operated two in series on 110 volts. When so operated and adjusted for a current consumption of ten amperes the manufacturer states that the lamps have an efficiency of one-quarter watt per mean hemispherical candle. Owing to the absence of obstructions below the arc, the distribution of light is very satisfactory. The light is of a pleasing appearance, and while the lamps have so far been little used except for outdoor illumination, they are well adapted for indoor illumination, particularly in railroad stations, ferry houses, foundries, machine shops and other places of like character.

All the metal parts, other than the top casting and the case, are nickel-plated.

The maker states that the lamp will burn equally well when operated four in series on 220 volts as when connected two in series on 110 volts. By the addition of two resistance spools, for which provision is made in every lamp, they can be adapted for single burning on 110 volts, or two in series on 220 volts. The maximum efficiency is secured when the lamps are connected two in series on 110 volts, or four in series on 220 volts.

All parts of these lamps are built to



INTERIOR VIEW OF "HELIOS" ENCLOSED FLAMING ARC LAMP.

standard gauge and are interchangeable. The resistance is self-contained. The carbons are 400 millimetres long, and the entire length of the lamp, from the top of the hanger eye to the bottom of the globe, is thirty inches, the weight being twenty-five pounds complete.

The Reflector-Stalactite.

The Holophane Company, sales department, New York city, has recently placed on the market a new "Reflector-Stalactite," similar in construction and application to its well-known Pagoda ball which has been largely used in the public buildings of this country.

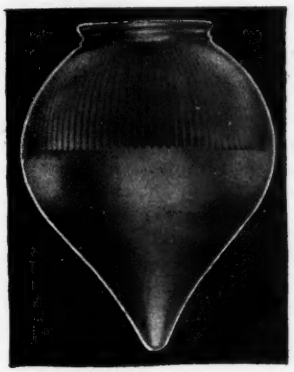


FIG. 1.—REFLECTOR-STALACTITE.

Fig. 1 shows one of these "Reflector-Stalactites," the upper part consisting of scientific prisms, while the lower part is of ground glass, the whole being made in one piece, thereby uniting the effects of the frosted glass with the efficiency of Holophane prisms. This globe is made for a three-and-one-quarter-inch holder, has a width of six inches and a height of seven and three-quarters inches.

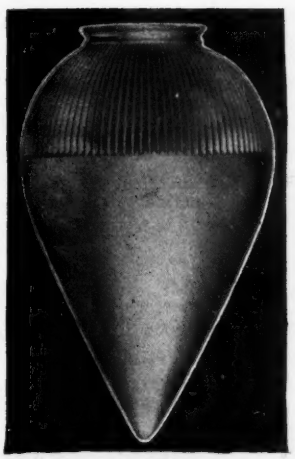


FIG. 2.—REFLECTOR-STALACTITE.

Fig. 2 shows a similar type of "Reflector-Stalactite," having exactly the same dimensions in regard to holder and width, but having a height of ten inches.

The globes in point of efficiency easily achieve the high standard set by the Holophane system. When lighted up, the result is very brilliant and altogether adds greatly to the artistic features of any place where used. The ground glass bottoms of these stalactites can be cut in a number of different patterns. In this way the beauties of cut glass are combined with the Holophane system of illumination. Lamps of from sixteen candle-power to twenty-two candle-power are recommended for use in these globes.

The Standard Electric and Chemical Company.

The old Standard Appliance Company, Chicago, Ill., has recently been reorganized under the name of the Standard Electric and Chemical Company, an Illinois corporation, with offices at 224-226 South Clinton street. The officers of the company are Albert Meyer, president, and John A. Hillesheim, secretary-treasurer.

PORTABLE LAMP GUARD.

The company manufactures electrical and chemical specialties. One of the specialties in the electrical line is a portable lamp guard. This has many distinct advantages, and is shown in the accompanying illustration. The lamp guard is shortened by several inches and made more compact in every detail by having an Edison socket in the handle, thus obviating the necessity of purchasing a socket to use in connection with it. The thirty-two-candle-power size is very little larger than the sixteen-candle-power size. The upper half or crown of the guard is fastened to the lower half by a bayonet joint. The socket can be removed for connection by loosening a set screw. The socket is thoroughly insulated from the guard and handle, and danger from grounding is eliminated. This lamp guard is also made with a key socket, which in many instances will prove a distinct advantage. The guard is approved by the fire underwriters.

New Contracts for Automatic Telephone Equipment.

The Automatic Electric Company, Chicago, Ill., announces the closing of a contract for 10,000 additional lines of automatic telephone equipment for the Home Telephone and Telegraph Company, of Los Angeles, Cal. This is for immediate installation in the new Olive Street exchange, and the completion of this exchange will practically mean the elimination of the manual equipment now in use in the present main exchange.

Other contracts placed with the Automatic Electric Company during the first two months of 1907 are: Home Telephone and Telegraph Company, Portland, Ore., 3,000 additional; Montana Independent Telephone Company, Butte, Mont., 2,000 lines; Home Telephone and Telegraph Company, Tacoma, Wash., 1,000 additional; Rushville Co-Operative Telephone Company, Rushville, Ind., 800 lines, and several additions to present Automatic exchanges.

Cable Hanger for Suspending Telephone and Telegraph Cables.

The accompanying illustration shows the "HP" rustless cable hanger for suspending telephone and telegraph cables, placed on the market by James S. Barron & Company, 206 West Broadway, New York city. These hangers are made of one piece of zinc, eliminating the possibility of electrolytic action between the parts and having no separate parts to become loosened or lost. They will not rust, and are strong and durable and a cable chair can pass readily over them without injuring either the hanger or the cable. The hanger is easily applied. The circular end of the hanger is held against the cable, the free end is wound around and passed through the lower slot, around again through the upper slot, over the suspension wire, and hooked into the upper slot, as shown in the illustration.

"HP" RUSTLESS HANGER.

Current Electrical News

DOMESTIC AND EXPORT.

ALLEGED DISCOVERY OF A NEW FUEL—Considerable discussion has been devoted, in some of the New York daily newspapers, to the alleged discovery, by John Ellmore, a resident of Altoona, Pa., of a solution, which, when combined with the dead ashes of coal, brings about a chemical dissociation of the water into hydrogen and oxygen, so that the ash, when treated with the solution, becomes molten, giving out a great degree of heat. Scientific men are not prepared to endorse the theory of Ellmore, nor to concede the results said to have been attained.

LARGE UTAH POWER DEVELOPMENT—F. W. C. Hathenbreuck and Sidney Bamberger have filed application with the state engineer for sixty-four second feet from the Green river in Wasatch county to develop 40,000 horse-power for furnishing power and light in Park City, Brigham, Salt Lake, Utah, and other places. The same parties also filed application for twenty-six second feet from the Green river in Wasatch county, for the development of 800 horse-power, with which to drive stamp mills and mining machinery in Wasatch county mines operated by the applicants.

LARGE GEORGIA POWER PLANT—It is announced that final arrangements have been perfected for the development of the power property of the Albany Power and Manufacturing Company, at Porter Shoals, on Flint river, two miles north of Albany, Ga. The development, which will cost about a million and a half dollars, will be undertaken at once, and it is expected that the dam and power-house will be completed within two years. The property will develop 10,000 electric horse-power. A portion of the power from the river development will be used by the Macon, Americus & Albany electric railway, the construction of which is to be undertaken in a few months.

WASHINGTON WATER POWER COMPANY—The stockholders of the Washington Water Power Company, at a meeting in Spokane, Wash., voted to increase the capital stock from $5,000,000 to $10,000,000. It is announced by Henry M. Richards, president of the company, that the money will be expended in the betterment of the electric railway system and the extension of several lines. The directors were reelected as follows: William A. White, George H. Southard and Frank Lyman, of New York; H. M. Richards, D. L. Huntington, J. D. Sherwood, Thomas G. Thomson, J. P. M. Richards, A. B. Campbell, J. N. Glover and Huber Rasher, of Spokane. The officers of the company reelected for the year are: president, Henry M. Richards; first vice-president, A. B. Campbell; second vice-president and general manager, D. L. Huntington; treasurer, H. E. Perks; secretary, H. L. Bleecker. The corporation has seventy-two and one-half miles of railroad, fifty-four and one-half miles of which is in Spokane. Its power transmission lines aggregate 225 miles, the longest being to the Coeur d'Alene mining camps, 110 miles.

DATES AHEAD.

West Virginia Independent Telephone Association. Wheeling, W. Va., April.

Iowa Electrical Association and Iowa Street and Interurban Railway Association. Annual meeting, Clinton, Iowa, April 18, 19 and 20.

Southwestern Gas, Electric and Street Railway Association. San Antonio, Texas, April 18-21.

Oklahoma Electric Light, Railway and Gas Association. Annual meeting, Oklahoma City, Okla., April 22-23.

Jamestown Tercentennial Exposition. Norfolk, Va., April 26 to November 30.

Texas State Electric and Gas Association. San Antonio, Texas, May 14-16.

American Society of Mechanical Engineers. Annual meeting, Indianapolis, Ind., May 28-31.

National Electric Light Association. Annual meeting, Washington, D. C., June 4, 5, 6 and 7.

Association of Railway Telegraph Superintendents. Annual meeting, Atlantic City, N. J., June 19-20.

American Institute of Electrical Engineers. Annual meeting, Niagara Falls, N. Y., week of June 24.

ELECTRIC RAILWAYS.

ALBIA, IOWA—Albia has raised $25,000 for the proposed Oskaloosa-Buxton interurban line.

LOS ANGELES, CAL.—The new Covina line of the Pacific Electric Company is to be extended to Pomona.

WASHINGTON, PA.—The East Washington borough council has granted a franchise to the Pittsburg Railways Company.

DELAWARE, OHIO—The Lima, Kenton & Marion branch of the Columbus Northern Traction Company is to be built this summer.

IOWA CITY, IOWA—The power plant for the Iowa City, Tipton & Davenport interurban railway will be located at the water dam near Rochester, on the Cedar river.

OPELIKA, ALA.—The city council of Opelika has granted a gas franchise and an electric street railway franchise to H. L. McKee, of Troy. These franchises are granted for a term of thirty years.

JANESVILLE, WIS.—H. H. Clough of the proposed Madison-Janesville interurban line, has filed the company's formal acceptance of the franchise granted to it some months ago by the council.

LOUISVILLE, KY.—The directors of the Louisville Traction Company have reelected officers as follows: T. J. Minary, president; Alex P. Humphrey, vice-president, and Samuel Boyle, secretary and treasurer.

BERLIN, PA.—The borough council has granted a franchise to the Pennsylvania & Maryland Street Railway Company, which proposes to build a line through the town to Somerset. The ordinance grants a twenty-year franchise.

SHERMAN, TEXAS—The Texas Traction Company, now constructing an interurban line between Sherman and Dallas, Texas, has filed a chattel mortgage and deed of trust to the Old Colony Trust Company, of Boston, Mass., for $2,000,000.

YAZOO CITY, MISS.—The city council of Yazoo City has let a contract to the Sanders-Johnson Company, of Vicksburg, to build and equip the Yazoo City street railway. The line will cost complete $50,000, and will be about three miles long. It is to be in operation in July.

BELLAIRE, OHIO—The capital stock of the Bellaire Southwestern Traction Company has been increased from $100,000 to $500,000. This action will be followed soon by extensive preparations for an extension of the line now being built from Bellaire to Shadyside.

EUGENE, ORE.—Simon Klovdahl has been employed by the Willamette Valley Company to have charge of the work of surveying for the street railway line, the Eugene-Springfield line and the line which the company intends to build up the McKenzie to the Blue river mines.

CINCINNATI, OHIO—W. Kelsey Schoepf, acting for the Widener-Elkins syndicate, has acquired two Indiana trolley systems which will be merged into the Terre Haute, Indianapolis & Eastern. The two roads acquired are the Indianapolis & Western, and the Indianapolis & Plainfield.

WATERTOWN, N. Y.—In the issue of the ELECTRICAL REVIEW for March 2 it was announced that the New York Northern Railway Company had been organized with Foster P. Shines, of Watertown, as president. An error was made in this designation. The name should have been printed Foster P. Rhines.

MURPHYSBORO, ILL.—At a meeting of the Southern Illinois Transit Company the following directors were elected: I. W. Newcomer, Phil Decker, of Murphysboro; Edward Elles, of Carterville; Henry Crawshaw, of Carbondale, and George P. Heckel. The di-

rectors then chose the following officers: president, I. W. Newcomer; secretary, Trent Becraft; treasurer, Phil Decker.

ELIZABETHTOWN, KY.—The Kentucky Central Traction Railway Company has begun surveying an electric railway line parallel with the old Louisville & Nashville pike between West Point and Elizabethtown. The distance is about twenty-two miles and the work of construction will begin when the survey is completed. The line will be extended from West Point to Louisville.

ROCHESTER, N. Y.—The Appellate Division of the Supreme Court has handed down a decision in which the state railroad commission is ordered to grant a certificate of convenience and necessity to the Rochester & Southern Construction Company to build a road from Rochester to Corning, Elmira and other southern points, which certificate had been previously denied by the commission.

CHATTANOOGA, TENN.—The board of trade of Dalton has secured the necessary right of way for the Georgia-Tennessee Interurban Electric Railway Company, which is to build an electric line from Chattanooga to Spring Place, Ga. The right of way has been secured over the surveys of the Dalton & Alaculsey Railway. S. W. Divine, promoter of the road, says work will begin on the road early in April.

EVANSVILLE, IND.—The Evansville & Southern Indiana Traction Company has filed a mortgage at Evansville, securing an issue of $4,000,000 five per cent thirty-year gold bonds, which are to be used in liquidating the debts of the company and for the redemption of bonds of the Evansville Electric Railway Company and the Evansville, Princeton & Vincennes Traction Company, which concerns have been absorbed.

PHILADELPHIA, PA.—The directors of the West Jersey & Sea Shore Railroad have organized by electing James McCrea, president; John P. Green, first vice-president, Charles E. Pugh, second vice-president; Samuel Rea, third vice-president, and J. B. Thayer, fourth vice-president. Henry Tatnall was elected a director to act as fifth vice-president and treasurer. John W. Harding was elected secretary and Louis Nelson and Kane Green assistant secretaries.

NEWARK, OHIO—Actual work on the construction of the Newark, Martinsburg & Mt. Vernon Electric Railway has been commenced under the supervision of John A. Chilcote, who, with other promoters of the enterprise, announces that cars will be running next fall. Right of way from Wooster to Mt. Vernon is being secured, and, when this line is finished, it will give Newark an air line to Cleveland. Eastern men are said to have financed the road.

GRAFTON, W. VA.—Colonel John T. McGraw has been elected president of the City Traction Company, which will begin the construction of a street railway system in Grafton at once. The first section of the road will be a mile long. The other officers elected were: vice-president, D. S. Overholt, Scottdale, Pa.; treasurer, C. E. Conaway, Fairmont, W. Va.; secretary, T. A. Deveney, Grafton. The executive board is composed of Messrs. Overholt, McGraw, Deveney and Conaway.

BABYLON, L. I.—The town board has granted to the Huntington Railroad Company a perpetual franchise for the extension and operation of its proposed trolley line from the terminus of the previous franchise, north of the village of Amityville, thence easterly over a private right of way to Copiaque; thence through Lindenhurst to Babylon, where it will connect with the line of the Babylon street railroad which is now owned by the Long Island Railroad Company and which extends to the shore front on Great South Bay.

ALBANY, N. Y.—Authority has been granted the Syracuse, Lake Shore & Northern Railroad Company to increase its capital stock from $2,250,000 to $3,500,000. The company has taken over certain roads heretofore built and contemplates operating a continuous line from Syracuse to Oswego. The Auburn & Northern Electric Railroad Company has authority to increase its capital from $250,000 to $1,500,000. The company is to operate a street railroad from Auburn to Port Byron and from Auburn to Cayuga and across Cayuga lake to Seneca Falls.

SPOKANE, WASH.—The Tekoa-Saint Maries River Railroad Company has elected these officers: president, F. J. Mahoney; vice-president, E. C. Dowel; secretary, M. D. O'Connell; treasurer, Dr. W. A. Mosier; also a directorate of fifteen members. The line will extend from Tekoa, Wash., south of Spokane, to Indian Creek and will be in operation in time to move the season's crops. Electricity will be the motive power, and street-cars will be operated in Tekoa. The line will ultimately be extended to the timber belts of the St. Maries river in Idaho.

OAKLAND, CAL.—F. M. Greenwood, who obtained a franchise a year ago from the board of trustees of the city of Alameda to build and operate an electric line of railway through that city in connection with a ferry service to San Francisco, has organized a company for that purpose under the name of the San Francisco, Alameda & Eastern Railway Company. The company has a capital of $2,000,000. The directors are F. M. Greenwood, A. D. Schindler, A. H. McHuron, W. H. Spalding and L. Q. Haven. Of the capital stock $11,000 has actually been subscribed.

SPRINGFIELD, MASS.—H. C. Page, general manager of the Springfield Street Railway Company, states that the $510,000 which the street railway will derive through the issue of $300,000 in stock at $170 a share, will be spent in additions to the power plant to cost $250,000, in new cars, and in a telephone system by which it will be possible for headquarters to keep in touch with every car in the system. The increase in capital authorized by the state railroad commissioners will make the total capitalization of the street railway $2,258,400, to which it is understood will be added the stock of the Woronoco Street Railway Company, capitalized at $250,000, and of the Springfield & Eastern Street Railway Company, which has a capital of $370,000.

CINCINNATI, OHIO—Contracts have been signed in Cincinnati which insure the completion and operation of an up-to-date and direct traction line between Cincinnati and Toledo before May 1, 1908. Three of the contracts signed call for thirty-one miles of grading and concrete and steel bridges, from Leipsic to Toledo; for forty-five miles of grading and similar bridging from Lima to Bellefontaine, and for nine miles of reconstruction work between Middletown and Hamilton. They were awarded to J. C. Carland, of Toledo, by the Indiana, Columbus and Eastern Traction Company for the Lima-Bellefontaine work; by the Stratford Construction Company, of New York, for the Leipsic-Toledo work, and by the Cincinnati Northern Traction Company for the Middletown-Hamilton work. This construction will provide a direct line, by connection at Leipsic, Lima and Bellefontaine, from the Ohio river to Lake Erie, in addition to better and increased traction facilities east and west.

NEW MANUFACTURING COMPANIES.

TRUMANSBURG, N. Y.—The Electric Fittings Company has been incorporated with a capital of $125,000.

EAST LIVERPOOL, OHIO—The Ceramic Electrical Company, of East Liverpool, has been incorporated to take over the electrical business of the Milligan Hardware and Supply Company.

DENVER, COL.—The John O. Stivers Electrical Company has been incorporated with a capital of $100,000. The incorporators are John O. Stivers, Henry Broadhurst and Albert B. Smith, of Denver.

TRENTON, N. J.—The Trenton Gas and Electric Fixture Company has been incorporated with a capital stock of $50,000. The officers are: president, Charles S. Reichert; vice-president, Charles Geers, Philadelphia; secretary-treasurer, August Peters, Philadelphia.

ALBANY, N. Y.—The Sterling Conduit Company, of Troy, with capital of $1,000, has been incorporated to manufacture electrical conduits and conductors. The directors are M. M. Waterman and Harry A Waterman, of Troy, and John W. and Robert Garland and F. G. Hodkinson, of Pittsburg.

NORWICH, CT.—The Norwich Electric Company, of Norwich, has filed a certificate of incorporation with the state secretary in Hartford. The capital stock is $5,000. Charles J. Twist, James M. Fillmore and Carroll L. Adams are the incorporators. The new concern will do an electric wiring business and deal in electrical supplies.

NEW INCORPORATIONS.

MADISON, WIS.—Jackson Telephone Company. Increased from $2,000 to $4,000.

SPRINGFIELD, ILL.—Pioneer Telephone Company, El Paso. $1,000. Incorporators: William Eft, Lewis C. Kindon, Charles C. Brown.

DENVER, COL.—Palisade Light, Heat and Power Company. $50,000. Incorporators: J. N. Stoddard, D. L. Webb and W. A. Burke.

NEW ATHENS, ILL.—Tomorroway Telephone Association, New Athens. $300. Incorporators: Frank Reisert, John Koch, Fred Stenzel.

HARRISBURG, PA.—The Indiana, Punxsutawney & Sagamore Street Railway Company. $210,000. To build thirty-five miles of road in Indiana county.

INDIANAPOLIS, IND.—Lewis Telephone Company, Vigo, Clay, Sullivan and Greene counties. $10,000. Directors: C. C. Givens, W. W. Woodron, C. W. Boston, J. N. Woods and A. B. Melch.

ALBANY, N. Y.—Seashore Municipal Railroad Company, Hempstead. To operate a five-mile street surface line, Hemstead to East Rockaway. $150,000. Directors: G. A. Green, M. A. Day, Brooklyn; H. W. Griffiths, Hempstead; M. J. White, New York.

INDIANAPOLIS, IND.—Patrons' Mutual Telegraph Company, Plymouth. $50,000. Directors: Warren McFarlin, G. D. Hartman, N. A. Goodrich, V. A. Lidecker, C. W. Heim, S. A. Garn, P. E. Searles, L. M. Lauer, G. P. Morlock and William Beck.

SALT LAKE CITY, UTAH—Cedar City Light and Power Company, of Cedar City. To operate a light and power system in Iron county. $13,000. G. W. Decker, president; L. W. Jones, vice-president; J. H. Arthur, secretary; Henry Leigh, treasurer.

LOS ANGELES, CAL.—Sierra Nevada Electric Company. $1,000,000, of which $6,000 has been subscribed. Organized to hold and protect certain water rights on the San Joaquin river. Incorporators: H. E. Huntington, W. G. Kerckhoff and others.

BELLEVILLE, ILL.—Belleville & Interurban Railroad Company, of Belleville. $100,000. Incorporators: Jacob Gundlach, Jr., Benjamin A. Gundlach, K. W. Hofsommer, George Hippard and Thomas A. Bell. To construct an electric road from Belleville to Smithton.

ALBANY, N. Y.—Syracuse & South Bay Electric Railroad Company, of Syracuse. To operate a street surface road from Syracuse to South Bay, on Oneida Lake, a distance of eleven miles. $1,500,000. Directors: A. K. Hiscock, W. Nottingham, C. A. Lux, all of Syracuse.

FRANKFORT, KY.—Henderson Traction Company, Henderson county. $150,000. Incorporators: Walter Schmidt, Cincinnati; James W. Garrison and Samuel McDonald, of Louisville; C. C. Tennis, Pittsburg, Pa.; A. O. Brown & Company, of New York, and J. H. Lyne, Henderson.

INDIANAPOLIS, IND.—Parkersburg Telephone Company, Ladoga. $2,000. Directors: D. S. Armstrong, J. I. Flanigan, Henry Fall, J. M. Nicholas, Arthur Nicholas, James Akers, Abe Fink, S. L. James, John Fendley, R. A. Fendley, T. A. Scott, Hillery Tool, J. N. La Follett, W. C. Whitaker and J. R. Welch.

RICHMOND, VA.—Wylliesburg Telephone Company, Wylliesburg. C. B. Robertson, president; W. P. McGuire, medical director; W. H. Owens, vice-president; A. H. Zollinger, secretary and treasurer; J. T. Jennings, all of Wylliesburg, Va. $1,000 to $5,000. Object and purposes: telephone lines in Mecklenburg, Halifax and Charlotte counties.

WATERTOWN, N. Y.—The Beaver River Light and Power Company. $40,000. Directors: James P. Lewis, H. L. VanArnam and H. S. VanArnam, of Beaver Falls, and H. W. Holt, of Lowville. Formed for the purpose of developing electrical power in Black river and to carry on operations in the villages of Lowville, Beaver Falls, Croghan and Castorland, as well as the towns of Lowville, New Bremen, Croghan and Denmark.

OLYMPIA, WASH.—Hannaford Valley Railway Company, of Seattle. $150,000. Incorporators: E. B. Cox, H. W. Treat, P. H. Smith. Principal object, to build a railway operated by steam, electric or other mechanical power, from Centralia, in the state of Washington, in a northeasterly or northerly direction, through the counties of Lewis, Thurston and Pierce to a terminal on tidewater at or near Tacoma, in the state of Washington.

OBITUARY NOTES.

DR. OTIS C. WHITE, president of the O. C. White Company, Worcester, Mass., manufacturer of electrical appliances, died at his home in that city on March 11, after an illness of four weeks. Dr. White was a retired dentist and an inventor of some note. He was born in Millbury, Mass., seventy years ago, and is survived by his wife and a son and daughter.

MR. ARTHUR D. NEWTON, manager of the electrical department of the Boston branch of the H. W. Johns-Manville Company, died on Wednesday, March 13, from an attack of grippe. Mr. Newton was well known and greatly admired throughout the entire electrical fraternity. He was the founder of the Eddy Electric Company, which had headquarters at Hartford, Ct., and which for years was one of the large manufacturing concerns of New England. He had many close business and personal friends throughout the New England states who will greatly regret to learn of his sudden demise.

PERSONAL MENTION.

MR. ORAL A. STEVENS has resigned as division superintendent of the Boston & Northern Street Railway at Lowell, Mass., and is succeeded by W. E. Maloney.

DR. HOWARD T. BARNES, associate professor of physics, McGill University, Montreal, Canada, has been appointed to the chair in the faculty of applied science, to be vacated presently by Professor Ernest Rutherford.

MR. RALPH D. MERSHON was the guest of the Marquis of Winchester, director of the Victoria Falls Power Company, at the Hotel Ritz, London, England, on the evening of March 8. Mr. Mershon made a brief visit to England to advise in connection with this South African installation.

MR. W. E. ROLSTON has been appointed local superintendent of the Buffalo & Lake Erie Traction Company, at Dunkirk, N. Y. Mr. Rolston was for some time associated with J. R. Harrigan, formerly superintendent of the Canton (Ohio) street railway system, and now assistant general manager of the Buffalo & Lake Erie Traction Company.

MR. CHARLES H. ARMATAGE, who has served as express manager of the United Traction Company, Albany, N. Y., during the past six months, has been appointed traffic manager for the Delaware & Hudson trolley lines. Mr. Armatage will hereafter have charge of both freight and passenger traffic over these lines. His office is to be located in the general offices of the United Traction Company, Albany.

MR. HUGH L. THOMAS, who has been assistant to the general manager of the Rocky Mountain Bell Telephone Company at Salt Lake City, Utah, with the title of contract agent, has been promoted in the telephone service, having accepted a position with the Pacific States Telephone Company. Mr. Thomas will have charge of the Northwest territory of the company, including the coast. He will assume the duties of his new position May 1.

MR. WILLIAM R. GOODMAN has recently resigned the position of secretary of the Chicago Fuse Wire and Manufacturing Company and has severed active connection with the company, in order to devote his full time to the interests of the Whitely Exerciser Company, with which business he has also been connected for some twelve or thirteen years. It is with much regret that he leaves the work and associations in the electrical field, which have existed for over eighteen years and which have been exceedingly pleasant.

MR. CHARLES A. WESTON has been appointed manager of the New England Telephone and Telegraph Company's Concord (N. H.) exchange, succeeding Carleton H. Cook. Mr. Weston has had a wide experience in telephone work, beginning as night operator and inspector at the New England company's Milford (Mass.) exchange in 1900. After that he was division inspector and instrument man

for the central division of the New England system, in which Concord is included, and then was chief operator of the Fitchburg, Mass., exchange for five years.

MR. ALBERT M. STANLEY, former general manager of the Public Service Corporation of New Jersey, is going to London to take charge of the Yerkes system of underground railroads, which have not been a financial success under English management. A dinner was given to Mr. Stanley in the Astor Gallery of the Waldorf on Friday, March 22, on the eve of his departure. Mr. Stanley is only thirty-four years old. Thomas N. McCarter, president of the Public Service Corporation, presided at the dinner. His friends presented Mr. Stanley with a $400 watch.

MR. EGBERT DOUGLAS, electrical engineer of the Cataract Power and Conduit Company, Buffalo, N. Y., has been appointed head of the power-selling department of the Electric Bond and Share Company, of New York city, and will leave Buffalo on April 1. Mr. Douglas was for sixteen years with the General Electric Company, and had charge of the rebuilding of the power-houses of the International Railway Company in Buffalo, Niagara Falls and Lockport, N. Y. Upon the completion of this work Mr. Douglas took charge of the power-selling department of the Cataract Power and Conduit Company. Mr. Douglas's successor is August Smith, who has been with the General Electric Company.

MR. F. W. CASLER, who has been superintendent of the Manchester street power station of the Rhode Island Company, Providence, R. I., since it was built, has severed his connection with the company and will go to Boston, where he will take charge of the Lincoln street wharf power station of the Boston Elevated Railway Company. Mr. Casler has been with the Rhode Island Company for many years. Since the resignation of Chief Engineer Fred N. Bushnell Mr. Casler served as acting chief engineer until the appointment of M. H. Bronson. The employés of the company presented to him a handsome bookcase and a clock. G. W. Hawley, of Providence, has been selected to succeed Mr. Casler.

ELECTRICAL SECURITIES.

Following the quick rebound of prices of the latter part of last week, the past week witnessed another turn and the week closed with many leading industrials in no better condition, as far as prices go, than they were on March 13 and 14. It is likely, too, that a sagging tendency will predominate in the stock market for some time. Following the lead of the New York Central, the Erie and the Pennsylvania railroads have announced great retrenchments in their appropriations for improvements. The New York, New Haven & Hartford has also advised that expenditures for improvements and extensions will go on, but very circumspectly. All this because of the recommendations of the Public Utilities Bill, which is in danger of being passed favorably by both houses in the state of New York. The Erie has, in fact, stated that it would be useless for it to carry out its contemplated improvements unless it absolutely controlled its subsidiary lines.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 23.

New York:	*Closing.*
Allis-Chalmers common	11¾
Allis-Chalmers preferred	28
Brooklyn Rapid Transit	49¾
Consolidated Gas	116½
General Electric	143½
Interborough-Metropolitan common	24
Interborough-Metropolitan preferred	56
Kings County Electric	127
Mackay Companies (Postal Telegraph and Cables) common (ex-dividend)	66½
Mackay Companies (Postal Telegraph and Cables) preferred (ex-dividend)	65
Manhattan Elevated	132
Metropolitan Street Railway	93
New York & New Jersey Telephone	111
Western Union	79½
Westinghouse Manufacturing Company	149

The adjourned annual meeting of the Consolidated Gas Company has been adjourned again until May 21.

A quarterly dividend of 2½ per cent has been declared by the Westinghouse Electric and Manufacturing Company on the preferred, assenting and non-assenting stocks, payable April 10 to stockholders of record March 30. Books close March 30 and reopen April 11.

The income account of the Interborough Rapid Transit Company for the year ended December 31, 1906, is as follows: gross earnings, $20,916,147; operating expenses, $8,793,486; net earnings, $12,122,660; other income, $673,598; a total of $12,796,259; interest on bonds, $3,961,991, and taxes, $1,341,074; leaving a net income of $7,493,192. Deducting 7 per cent paid on Manhattan Railway stock leaves a surplus of $3,545,192, as against $2,504,142 for the previous year. The operating cost represents 42.04 per cent of the earnings. The number of passengers carried was 420,302,389, an increase of 54,127,910 over the previous year.

The new business of the General Electric Company since the first of February has exceeded all records for that period, running 20 per cent in excess of orders received in the corresponding period of last year. The foreign business of the company is also large, and the increase reported since February 1 corresponds with the increase in domestic business.

Boston:	*Closing.*
American Telephone and Telegraph	118½
Edison Electric Illuminating	212
Massachusetts Electric	57
New England Telephone	115
Western Telephone and Telegraph preferred	70

Philadelphia:	*Closing.*
Electric Company of America	9 1/16
Electric Storage Battery common	55
Electric Storage Battery preferred	55
Philadelphia Electric	7 1/16
Philadelphia Rapid Transit	16⅛
United Gas Improvement	84¼

The annual report of the Electric Storage Battery Company for the year ended December 31, 1906, shows a decrease in gross as compared witih the previous year of 9.25 per cent, while the decrease in net income was equal to 13.7 per cent. The amount earned on the $17,785,800 common stock now outstanding, after allowing for 5 per cent dividends on the $214,200 preferred stock now outstanding, was equal to 5.89 per cent, as compared with 6.76 per cent earned on the amount of outstanding stock in 1905. The report shows as follows: gross sales, $1,331,800; expenses, $401,093; net earnings, $930,707; other income, $128,666; total income, $1,059,373; dividends, $812,450; leaving a surplus of $246,923, as compared with $401,547 for 1905. The profit and loss surplus of the company as of December 31 last amounted to $3,754,451. This amount is equal to 20.86 per cent on the total amount of $18,000,000 capital stock outstanding.

Chicago:	*Closing.*
Chicago Telephone	118
Chicago Edison Light	136
Metropolitan Elevated preferred	65
National Carbon common	81
National Carbon preferred	115¼
Union Traction common	—
Union Traction preferred	—

The Commonwealth Electric Company, controlled by the Chicago Edison Company, has certified to the secretary of state an increase in its capital stock from $10,000,000 to $15,000,000. An officer of the company says the action was taken to provide for future requirements.

Negotiations for consolidating the Northwestern and Oak Park Elevated roads have been deferred on account of general financial conditions.

The Illinois Trust and Savings Bank has purchased the $375,000 South Side Elevated 4½ per cent first mortgage bonds held by the National City Bank, of New York.

Metropolitan Elevated earnings are $1,000 daily increase over a year ago. Some stockholders look for a 4 per cent dividend rate next fall and 5 per cent next year on the preferred, and say that in case of a merger the preferred should go in at par and the common at 50. There is talk of another beach amusement park project, which would add to the earnings considerably next summer. The annual meeting of Metropolitan Elevated will be held April 4.

TELEPHONE AND TELEGRAPH.

LANESBORO, MASS.—Plans are under way for the building of an additional telephone line from Pittsfield to Lanesboro.

BEATRICE, NEB.—The German Independent Telephone Company has elected R. H. Parde, president, and Albert Miller, secretary.

SPRINGFIELD, MASS.—At a cost of $20,000, the Western Union Telegraph Company has completely overhauled its twelve lines between Hartford, Ct., and Springfield.

GRAND HAVEN, MICH.—A wireless telegraph station is to be established at Grand Haven by a company of Milwaukee capitalists, and will connect Grand Haven with Milwaukee.

BELLEVILLE, ILL.—The Millstadt Telephone Company has sold to the St. Clair County Farmers' Mutual Telephone Company its switchboard, poles, wires and system in Millstadt.

OREGON CITY, ORE.—The city council has passed the ordinance granting the Home Telephone Company an additional franchise to operate a telephone exchange in this city.

PONTIAC, ILL.—The Livingston County Telephone Company will begin the active construction of its plant in Pontiac within a short time, the preliminaries already being well under way.

READING, PA.—On May 1, the Pennsylvania Telephone Company will put its new common battery system into service in this city after preparations covering almost a year and expenditures which will reach $100,000.

MONTREAL, CANADA—The Bell Telephone Company of Canada will issue $2,500,000 of stock, increasing its capital from $10,000,000 to $12,500,000. The new stock will be issued at $100 a share, compared with $125 at the last issue.

SHARON, PA.—The Bell Telephone Company is preparing to spend $200,000 for improvements in Sharon. All wires will be placed underground and a common battery system installed. A new office building is also projected.

NEW YORK, N. Y.—The New York Central Railroad has a large force of men working along its line stringing new telephone and telegraph wires. The Central controls its own telephone and telegraph system, and is now making many improvements, particularly in the Mohawk valley.

SPOKANE, WASH.—The Pacific Telephone and Telegraph Company announces that plans have been completed to install a common battery system at Dayton, Wash., to cost $15,000. The present system of ten-party residence and four-party business lines will be abolished for four-party residence and two-party business lines.

GRAFTON, N. D.—The city of Grafton has granted the North Dakota Independent Telephone Company both a local and long-distance franchise. The company is now building a line from Minto to Grafton and will later extend this line to the international boundary to meet one which is being constructed by the Canadian government.

CHEHALIS, WASH.—At a meeting of the Lewis county commissioners the Home Telephone Company, which is connected with the Northwestern Long-Distance Telephone Company, made application for a twenty-five-year franchise to operate through this county. At the Chehalis city council meeting, the same company made an application for a franchise for twenty-five years.

SPOKANE, WASH.—Extensive alterations and improvements are being made by the Pacific Telephone and Telegraph Company in its Spokane system and when these are completed it is announced that between 14,000 and 15,000 instruments will be in operation. The entire system is being overhauled and with the installation of the new switchboards the capacity will be increased from fifteen to twenty-five per cent. The company has unfilled orders for from 800 to 1,000 telephones, and under the old system it was impossible to put them into service. The principal change will be the installation of the central energy system.

EDUCATIONAL NOTE.

SYRACUSE UNIVERSITY—Syracuse University, Syracuse, N. Y., has issued a bulletin which gives general information regarding the summer school and teachers' college, which courses will be offered during the coming vacation. This bulletin describes the university equipment and buildings, and gives lists of the studies offered.

ELECTRIC LIGHTING.

DAVENPORT, IOWA—The Independent Light and Power Company has been granted a franchise to build a lighting plant in the city.

SHERBURNE, N. Y.—A proposition is to be submitted to the voters at the coming election to raise $15,000 for an electric light plant.

STERLING, NEB.—Fred Beuhler has abandoned his project of establishing an electric light plant after securing a franchise and subscription by the town for eighty street lights. The franchise will be transferred to any one who desires it.

VALPARAISO, IND.—Clarence Geist, president of the Valparaiso Lighting Company has purchased a new site at Michigan City for a plant there. Before the Michigan City council Mr. Geist said $75,000 worth of improvements would be made.

LOUISVILLE, KY.—At a meeting of the directors of the Louisville Lighting Company, contracts recently let to a St. Louis construction company for the placing of the company's electric light and power wires underground in the business section of the city were approved, and the work will begin immediately.

LAWTON, OKLA.—Within the next thirty days the Comanche Light and Power Company will begin the erection of a new brick building on the present site, to cost $7,500 and be fifty feet by ninety feet in size. When completed this building will be large enough to admit of increasing the capacity of the plant six times.

OTTAWA, ILL.—Ernest Freeman, president of the Marseilles Light and Water Company, has completed a deal whereby the United Electric Company, of which he is president, has bought the electric properties at Seneca and at Morris. The company at Seneca is the Seneca Electric Company and that at Morris the Fields Electric Light Company. Both these plants are now operated by steam, but in the future current will be generated at Marseilles and transmitted to Seneca and Morris. The distance to Morris is seventeen miles.

CRIPPLE CREEK, COL.—A deed filed in the county clerk's office conveys from the Gold Belt Consolidated Electric Company to the Pueblo and Suburban Traction and Lighting Company property of the former in the district, including its interests in notes and mortgages; property situated in Victor, Goldfield, Anaconda and South Altman, together with machinery and equipment and franchises given by those towns, all of which run for twenty-five years. Another deed conveys from Andrew W. Mellon the same property for a specified consideration of $29,885. A release of the deed of trust covering the same property was also recorded.

HOLLAND, MICH.—The city is confronted with the necessity of doubling the capacity of the municipal electric light plant and, according to estimates prepared by Superintendent James De Young, of the board of public works, the expense involved would approximate $30,000. Including public lighting, the plant this year will have an income of $35,000, which is about $15,000 above the operating expenses. The receipts for the month of January were $600 in excess of the same month last year. Mr. De Young figures that the income of the plant when doubled will be about $80,000. It is probable that the matter will be left to the voters at the coming election.

SPRINGFIELD, MASS.—The Palmer Electric Light Company, with its privileges and franchises, has been absorbed by the New York, New Haven & Hartford Railroad, through the New England Investment and Securities Company. The board of directors of the company resigned and a new board, comprising C. S. Mellen, president of the New York, New Haven & Hartford Railroad; L. S. Storrs, of the New England Securities Company, and several other men interested in the two organizations, took over the company and organized as the Central Massachusetts Electric Company. The same men were elected to fill the places in the directorate of the Springfield & Eastern Street Railway Company, which was leased by the New England Securities Company about a year ago. The officers of the newly formed Central Massachusetts Electric Company are as follows: C. S. Mellen, president; L. S. Storrs, vice-president; L. T. Harmer, comptroller; W. A. Skinner and H. C. Page. The Palmer Electric Light Company owns franchises to supply electricity to the towns of Palmer, North Wilbraham, Monson, Three Rivers, Bondsville, West Brookfield and Warren. The company also furnishes the power for the Springfield & Eastern Railway.

INDUSTRIAL ITEMS.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, has published a handsome catalogue descriptive of "The Standard" direct-current fans manufactured by this company.

THE DIELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has ready for distribution bulletin No. 1, descriptive of impregnating and cable compounds, and a condensed data sheet of "Dielectric" products.

THE PHOENIX ELECTRIC COMPANY, Mansfield, Ohio, has opened an office at 83 West Jackson Boulevard, Chicago, Ill., where it will carry motors and dynamos in stock. The office is in charge of John Nangle, formerly salesman for the Western Electric Company.

THE YOST MANUFACTURING COMPANY, Toledo, Ohio, has ready for distribution some interesting pamphlets of Yost sockets, the "Electrogrip," the double "Falcon" wrench, and "Fiberlite" shades. Any of this literature will be furnished to those interested upon request.

THE BALL ENGINE COMPANY, Erie, Pa., announces the opening of a branch office at 39 Cortlandt street, New York city, for the sale of its automatic and Corliss engines. This office will be under the management of Lancelot Copleston. The company has also opened a branch office at 1,213 Chemical Building, St. Louis, Mo., under the management of O. L. Collins.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is favoring some of its customers with a handsome postal card bearing an illustration of the new City Investing Building, now in course of erection at Broadway, Cortlandt and Church streets, New York city. The structural steel work above the street level is being protected from corrosion with Dixon's silica graphite paint.

W. S. BARSTOW & COMPANY, New York city, has enlarged its drafting department. Thomas Richardson, who has had a wide experience in power-plant design while connected with Westinghouse, Church, Kerr & Company, is in charge of this department. Associated with him, and in charge of steel structural designing, is Harold S. Richmond, who has been connected with the Boston Bridge Works, the Riverside Bridge Company, the Boston & Maine Railroad and Westinghouse, Church, Kerr & Company.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has secured a contract for supplying all of the air-brake equipments required for the electric railways operated or controlled by the New York, New Haven & Hartford Railroad Company. This is said to be one of the most important air-brake contracts ever placed, covering the equipment required by electric railways operating in thirty cities in New York, Massachusetts, Rhode Island and Connecticut. The number of cars in service at the present time aggregates a total of about 4,000. Approximately 1,400 of the heavier cars are already equipped with air brakes of various types, over 1,000 being of the Christensen type now manufactured by the Allis-Chalmers Company.

THE BRILLIANT ELECTRIC COMPANY, Cleveland, Ohio, announces that its business has developed to such an extent that it is unable to wait for the completion of its new factory at Conneaut, and has been compelled to vacate its general offices, which have been in the factory building, in order to give additional factory space for manufacturing purposes. The general offices will be located at 403-404 Electric Building, Cleveland, after April 1. A building contract has been let to the Moore Engineering Company, of Cleveland, for a $50,000 structure, and ground has been broken at Conneaut, where a modernly equipped lamp factory will be erected. An equipment costing at least $50,000 more will be installed at this plant.

THE WARREN ELECTRICAL MANUFACTURING COMPANY, Sandusky, Ohio, has purchased the plant and good will of the Warren Electric Manufacturing Company of this city, and in addition to manufacturing the well-known "Warren alternator," will manufacture a full line of revolving field type generators, also alternating-current and direct-current motors, transformers, etc. The officers of the new company will be Millard H. Nason, president, who is also vice-president of the Brilliant Electric Company, Cleveland, Ohio; Frank Warren, secretary, who has been secretary of the Warren Electric Manufacturing Company for a number of years, and Norman L. Hayden, general manager, who was president of the Hayden & Derby Manufacturing Company, New York city, for a term of years, and for the past five years general manager of the N. L. Hayden Manufacturing Company, Columbus, Ohio.

THE FRENCH BATTERY AND CARBON COMPANY, INCORPORATED, Madison, Wis., has become the sole importer in the United States of the battery products of Fabius Henrion, Nancy, France. The name of the company has been changed from the French Battery Company. The company announces that it is also in direct touch with producers of manganese, graphite, chemicals—in fact, everything which enters into the manufacture of dry batteries. A sufficient stock of imported materials will be kept in the warehouse in New York city to protect customers against delays in shipments from abroad. Inquiries regarding arc-lamp carbons should be addressed to the New York office, 59 and 61 Park Place. All business pertaining to the manufacture of dry batteries and battery supplies will be handled from the factory at Madison. The company states that the "Fleur de Lis" dry batteries which it manufactures have received a very cordial recognition on the American market. The Fabius Henrion establishment is one of the largest in Europe. The carbon products of this company have a well-established reputation, and are already well known to the American market.

Record of Electrical Patents.

Week of March 19.

847,305. TELEPHONE SET. George F. Atwood, East Orange, N. J., assignor to Western Electric Company, Chicago, Ill. A hand telephone mounted in a case.

847,310. THERMO-ELECTRIC ANNUNCIATOR. Severin O. Bestul, Iola, Wis. An expansion bar closes a bell circuit.

847,316. TELEPHONE SYSTEM. Charles L. Carr and Thaddeus P. Carr, Yellow Springs, Ohio. Each local station is controlled by a step-up magnet.

847,337. ELECTRICAL RAIL BOND. Alonzo F. Hooton, Greenfield, Ind. A laminated bond clamped under the rail.

847,355. SIGNALING APPARATUS FOR TELEPHONES. August A. Monson, Minneapolis, Minn. Signals are given by a slotted disc.

847,356. AUTOMATIC TELEPHONE SWITCHBOARD. August A. Monson, Minneapolis, Minn. Substations are provided, controlled from the central exchange.

847,367. TELEPHONE-SWITCH-OPERATING MECHANISM. Frank M. Potter, Jr., Rome, N. Y. A double-ended hook-switch.

847,372. LIGHTNING ARRESTER. Charles A. Rolfe, Adrian, Mich., assignor, by mesne assignments, to Rolfe Electric Company, Rochester, N. Y. A non-conductor placed between conducting terminals, which becomes conductive when heated.

847,385. TELEPHONE TRUNKING SYSTEM. Harry G. Webster, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A supervisory signal is associated with the outgoing end of the trunk.

847,395. LIGHT TRANSMITTING AND LIGHT DIFFUSING OBJECT. Ernest Böhm, London, England. Bulbous irregularities cast on a lamp globe.

847,396. PROCESS FOR PRODUCING LIGHT TRANSMITTING OBJECTS. Ernest Böhm, London, England. A method of producing bulbous irregularities on a lamp globe.

847,449. TRANSMITTER FRONT. Alfred H. Weiss, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A method of constructing a telephone transmitter front.

847,461. TELEPHONE-CALL METER. Charles T. Bradshaw, Philadelphia, Pa. A meter controlled from the exchange, which gives audible signals.

847,479. SYSTEM FOR ELECTRICALLY RELEASING DRAWERS IN CASH REGISTERS, ETC. Alfred G. Jackson, Brisbane, Queensland, Australia. The locks are released by electromagnets.

847,540. ELECTRIC METER. Claude W. Atkinson, Beckenham, England. An electrolytic meter.

847,546. INSULATOR FOR TENSION GUYS. Alexander E. Brown, Cleveland, Ohio, assignor to the Brown Hoisting Machinery Company, Cleveland, Ohio. A hollow insulating member, through which passes axially a supporting pin embedded in non-compressible material.

847,549. COIL BENDER. James A. Burns, Homestead, Pa., assignor to Westinghouse Electric and Manufacturing Company. A device for bending wire coils.

847,395.—Light Transmitting and Light Diffusing Object.

847,555. ADJUSTING DEVICE FOR RELAYS. Edward B. Craft, Chicago, Ill., assignor to Western Electric Company, Chicago, Ill. The retractile spring is attached to a pliable tongue.

847,566. ADJUSTABLE SUPPORT FOR VAPOR-LAMPS. Stanwood E. Flichtner, Englewood, N. J., assignor to Cooper Hewitt Electric Company. A photographic printing frame.

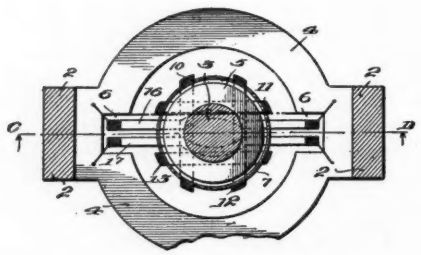
847,567. BLUE PRINTING AND SIMILAR APPARATUS. Stanwood E. Flichtner, Englewood, N. J., assignor to Cooper Hewitt Electric Company. A blue-printing machine using mercury vapor lamps.

847,580. ADJUSTABLE DROP-LIGHT. Henrik T. Jacobsen, Chicago, Ill. A spool through which the untwisted lamp cord is threaded.

847,624. ELECTRICAL MEASURING INSTRUMENT. Thomas W. Varley, New York, N. Y. A permanent-magnet meter.

847,656. TELEPHONE RELAY. Dilpert S. Dickert, Salt Lake City, Utah. Two magnetically operated transmitting devices are used, respectively shunted across the two lines.

847,663. SPEED-CONTROLLING DEVICE FOR ELECTRIC MOTORS. Thaddeus W. Hermans, Chicago, Ill. Two sets of resistances are connected in parallel.



847,624.—Electrical Measuring Instrument.

847,691. TELEPHONE ATTACHMENT. Alcorn Rector, New York, N. Y., assignor to himself, Daniel O. Sprague and Arthur P. Smith, New York, N. Y. A second ear piece is attached to the receiver by a sound tube.

847,701. TROLLEY AND CROSSOVER. Fredrich Schmunk and Paul B. Schmunk, Beaver Falls, Pa. An overhead trolley crossing.

847,741. ELECTRIC HAMMER. Winfield A. Denny, Anderson, Ind., assignor of one-third to Benjamin D. Emanuel and one-third to Clement W. Hooven, Anderson, Ind. The hammer is reciprocated by two solenoids.

847,743. CURRENT CONTROLLER. Richard Duckworth, Preston, England. A railway system, one rail of which is sectioned and charged by a switch operated by the car wheel.

847,746. ELECTRICAL WELDING APPARATUS. Thomas A. Edison, Orange, N. J. Employs an arc from a rotated carbon electrode.

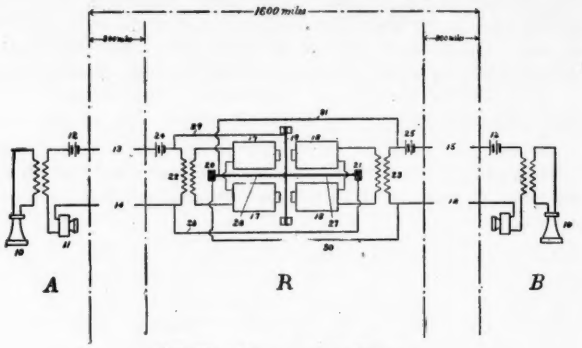
847,750. SLIDING JACK-SWITCH. George F. Espy, Union Furnace, Pa. A number of spring jacks mounted on a slide.

847,777. TELEPHONIC REPEATING CIRCUIT AND APPARATUS. Fernand Emile de Faucheux d'Humy, Englewood, N. J. A divided telephone line using differential repeating devices.

847,842. TELEPHONE RECEIVER. Louis Steinberger, New York, N. Y. A method of construction.

847,851. REVOLVING MERCURY-DIP CURRENT INTERRUPTER. Francis M. C. Usher, Fulton, Ky., and Consuelo A. Seoane, Merrifield, Va. The mercury surface and the steel contact needles are revolved about eccentric centres.

847,877. ELECTRIC CURRENT INTERRUPTING AND VARYING APPARATUS. Emile Bachelet, New York, N. Y. A device for changing the rate of interruption.



847,656.—Telephone Relay.

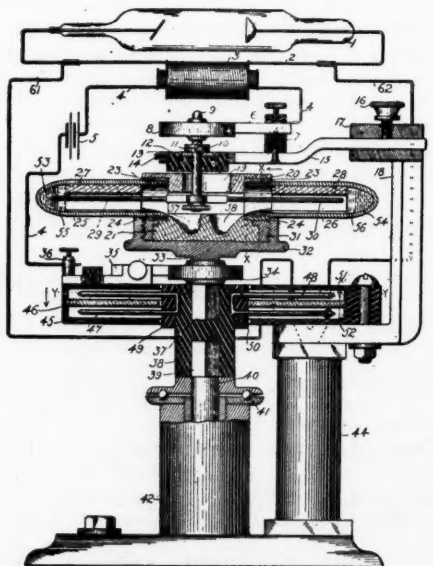
847,905. ELECTRIC SIGNAL SYSTEM. Eugenio Chouteau, Jr., St. Louis, Mo. Each locomotive is equipped with two alarms, one sensitive, the other insensitive, actuated by a wire parallel to the track.

847,925. SWITCH. Alfred L. Eustice, Chicago, Ill. A time switch.

847,935. ELECTRICAL GROUNDING DEVICE. John F. Golding, Washington, D. C., assignor to Monolith Steel Company, Incorporated. The conductor is laid in grooves in a driving bar.

847,939. COMBINED PULL AND KEY SOCKET. John H. Hanson, Chicago, Ill. A key socket with pull cord attachment.

847,974. ALTERNATING-CURRENT PLANT COMBINED WITH STORAGE BATTERY. Ludwig Schröder and Adolph Müller, Berlin, Germany. A storage battery charged by a motor-generator.



847,851.—Revolving Mercury-Dip Current Interrupter.

847,981. THERMOSTAT. Peabody A. Brown, Denver, Col. A compound expansion bar.

847,984. TELEPHONE TRUNKING SYSTEM. Francis W. Dunbar, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A trunk relay is used at the incoming end.

847,989. TROLLEY-WIRE CROSSING. James N. Hayes, St. Louis, Mo. A crossing for overhead wires.